DEPARTMENT OF AGRICULTURE.
BUREAU OF CHEMISTRY.
BULLETIN No. 4.

AN INVESTIGATION
OF
THE COMPOSITION
OF
AMERICAN WHEAT AND CORN.

SECOND REPORT.

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ASSISTANT CHEMIST.

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WASHINGTON, *September* 16, 1884.

SIR: I have the honor to present for publication the results of a continuation of the "Investigation of the Composition of American Wheat and Corn," the beginning of which appeared as Bulletin No. 1 of the Chemical Division of this Department.

Respectfully,

CLIFFORD RICHARDSON,
Assistant Chemist.

HON. GEO. B. LORING,
Commissioner.

SCOPE OF THE INVESTIGATION FOR 1883-'84.

The investigation of the past year has been confined almost entirely to wheat and its products, previous analyses of corn having been sufficient in number to demonstrate the very universal uniformity of its composition. A number of weighings of varieties of the latter have been made, however, to obtain information as to the sizes of kernels grown in different portions of the country, and a few determinations of ash and albuminoids.

The wheats which have been analyzed, while including some scattered specimens, which have from time to time come to hand, have been principally from parts of the country which were not well represented in our previous report or where those which have been selected were deemed by good judges to be not truly characteristic of the State; as in the case of Minnesota. A selection from Professor Blount's crop of 1883 has also been examined, it being the third consecutive year in which Colorado varieties grown under his direction have been analyzed. The roller process of milling having attracted much attention and taken a prominent position in the methods of milling at the present day, a complete series of samples illustrative thereof has been supplied by C. A. Pillsbury & Co., of Minneapolis, and partial series by Warder & Barnett, of Springfield, Ohio, and Herr & Cissel, Georgetown, D. C., together with numerous flours from different millers in Minnesota and elsewhere, manufactured by gradual reduction.

The question of the susceptibility of flour and other grain products to the humidity of the atmosphere has also been a subject of consideration, and baking experiments with flours from various States and of different grades have been carried on for comparison with similar work done in England a few years ago in which some of our wheats were included.

LIST OF WHEATS.

Grown by Hugh L. Wysor, Newbern, Pulaski County, Virginia.

1844. *Dallas.*

Crop of 1883. Soil a very light sand; no fertilizers. The land has been in clover about four years; the clover had run out when the land was broken in the fall of 1882; sown broadcast and plowed in; no after-cultivation. Yield: Three-quarters winter killed; the remainder gave 15 bushels per acre, weighing 68 pounds per bushel.

1845. *Fultz-Clawson.*

Crop of 1883. Grown under the same conditions as the preceding.

Grown by Peter L. J. Cogan, Addison, Webster County, West Virginia.

1846. *Early Amber.*

Crop of 1883. Soil a loam with clay subsoil; no fertilizers; grain sown on corn stubble and plowed in with shovel-plow. Yield: 10 or 12 bushels per acre.

Grown by Jacob W. Wharton, Forney, Cherokee County, Alabama.

1847. *Dallas.*

Crop of 1883. Soil an upland, gravelly ridge; no fertilizer. The soil had been in cotton the previous year and the cotton was manured with a compost of phosphate, stable manure, and cotton-seed at the rate of 300 to 400 pounds per acre. The seed was put in as follows: A furrow was run under the cotton stalks, plowing them out, and the seed being put in was turned under with a horse-turner or sometimes a small scooter, plowing the land as thoroughly as possible. Yield: 10 to 12 bushels per acre, weighing 60 pounds per bushel.

1848. *Dallas.*

Crop of 1883. Like the previous sample, but grown in a valley on loam, not so gravelly, between a gray and red in color. Yield: The same.

Grown by R. W. Gibbins, Hot Springs, Garland County, Arkansas.

1849. *Red Mediterranean.*

Crop of 1883; soil, clay; no fertilizer; ground turned with a two-horse plow; wheat sowed broadcast and harrowed in; yield, 5 bushels, weighing 50 pounds.

Grown by J. P. Hooke, Maryville, Blount County, Tennessee.

1850. (*Name lost.*)

Crop of 1883; soil, a light clay; no fertilizer, the soil having been manured the previous spring and cultivated in sweet potatoes. The wheat was sown about October 20 and plowed in with a bull-tongue as soon as the potatoes were dug. Yield, 6 bushels per acre, of very poor quality, worth 75 cents per bushel.

Grown by Elliott T. Brady, Buffalo Forge, Rockbridge County, Virginia.

1851. *White Mediterranean.*

Crop of 1883; soil, heavy red clay. Land was first well plowed and harrowed twice with "Acme harrow," which thoroughly pulverized it. The seed was sown (3 quarts) with a drill, at the rate of 1½ bushels per acre and finally top-dressed with well-rotted stable manure at the rate of 15 loads per acre. No other cultivation. The land had previously been in wheat; yield, 5¾ bushels from $\frac{1}{16}$ acre, or at the rate of 92 bushels per acre, weighing 64 pounds to the bushel. "This is a most *extraordinary* yield, but is *strictly true in every particular.*"

1852. *Australian.*

Crop of 1883. The origin of this specimen is unfortunately unknown.

Grown by John Q. Barker, Indian Wells, Summers County, West Virginia.

1853. *Osterey.*

Crop of 1883; soil, gravelly; no fertilizers; second year of cultivation; sown broadcast on corn stubble and plowed in with a bull-tongue; yield, 15 bushels per acre, weighing 62 pounds.

From the Northern Pacific Railroad, Washington Territory.

1854. *Wheat.*

Distributed to guests of the Northern Pacific Railroad at a banquet at Walla Walla, Washington Territory, October, 1883; crop of 1883.

From the Mills of Warder & Barnett, Springfield, Ohio.

1855. *Wheat.*
Used by the above firm for milling purposes. Crop of 1883.

From Morton & Co., Fargo, Dak.

Crop of 1883.

1861. *Hard Spring wheat.*
From the farm of L. S. Hurd, Cass County, Dakota. NE. ¼, 3, 138, 49. Yield, 24¾ bushels per acre.

1862. *Hard Spring wheat.*
From the farm of C. A. Morton, Red River of the North, Cass County, Dakota. Yield, 26$\frac{16}{60}$ bushels per acre.

1863. *Hard Spring wheat.*
From the farm of Terence Martin, Cass County, Dakota. S. 14, 141, 51. Yield, 25½ bushels per acre.

1864. *Hard Spring wheat.*
From the farm of C. M. Palmer, Cass County, Dakota. Yield, 26½ bushels per acre.

1865. *Hard Spring wheat.*
From the farm of Morton & Co., Cass County, Dakota. S. 32, 142, 50. Yield, 27 bushels per acre.

1866. *Hard Spring wheat.*
From the farm of Hans Larson, Cass County, Dakota. S. 10, 141, 49. Yield, 27½ bushels per acre.

1867. *Hard Spring wheat.*
From the farm of Martin Erickson, Cass County, Dakota. SE. ¼, 11, 141, 49. Yield, 36 bushels per acre.

From Springer Harbaugh, Saint Paul, Minn.

1868. *Scotch Fife.*
From Keystone & Lockhardt farms, Polk County, Minnesota. Crop of 1883.

From Sykes & Hughes, Jamestown, Dak.

1869. *Hard Spring wheat.*
From the farm of D. F. Salisbury. S. 21, 134, 64. La Moure County, Dakota. Crop of 1883.

From C. A. Pillsbury & Co., Minneapolis, Minn.

2001. *Wheat No. 1, Spring.*
Used by the above firm for milling purposes. Crop of 1883.

2106. *Sackatchiwan, Scotch Fife.*
Crop of 1883.

2107. *Scotch Fife.*
Minneapolis No. 1, hard. Crop of 1883.

From H. W. Donaldson, Saint Paul, Minn.

2108. *Hard Spring wheat.*
Crop of 1883. Selected for seed.

2109. *Red Fife.*
Crop of 1883.

From Springer Harbaugh, Saint Paul, Minn.

2110. *Hard Spring wheat.*
From Pembina, Dak. Crop of 1883.

From R. Sykes & Hughes, Jamestown, Dak.

2111. *Hard Spring wheat.*
Grown in La Moure County, Dakota. Crop of 1883.

Grown by Pickering Dodge, Shenandoah Alum Springs, Shenandoah County, Virginia.

2112. *Osterey.*
Crop of 1883, from seed distributed by the Department.

2113. *Red Wheat.*
Crop of 1883, from seed described and analyzed in Bulletin No. 1, serial No. 782.

Grown by William Martin, Catawissa Depot, Pa.

2122. *Martin's Amber.*
Crop of 1883. Variety described in Pennsylvania Agricultural Report for 1882. Selected seed.

Grown by Prof. A. E. Blount, Fort Collins, Colorado; crop of 1883.

2123. *Eldorado*, collection No. 6. Previously analyzed as serial No. 728, crop of 1881.
2124. *Defiance*, collection No. 8.
2125. *Blount's Hybrid*, No. 9.
2126. *Blount's Hybrid*, No. 10.
Previously analyzed as serial No. 719, crop of 1881.
2127. *Oregon Club*, collection No. 10.
Previously analyzed as serial No. 735, crop of 1881.
2128. *White Mexican*, collection No. 13.
Previously analyzed as serial No. 729, crop of 1881.
2129. *Improved Fife*, collection No. 14.
Previously analyzed as serial No. 740, crop of 1881.
2130. *Russian*, collection No. 15.
Previously analyzed as serial No. 734, crop of 1881.
2131. *Blount's Hybrid*, No. 15.
Previously analyzed as serial No. 720, crop of 1881.
2132. *Blount's Hybrid*, No. 16.
Previously analyzed as serial No. 721, crop of 1881.
2133. *Sonora*, collection No. 12.
Previously analyzed as serial No. 739, crop of 1881.
2134. *Rio Grande*, collection No. 17.
Previously analyzed as serial No. 735, crop of 1881.
2135. *Blount's Hybrid*, No. 17.
Previously analyzed as serial No. 722, crop of 1881.
2136. *Blount's Hybrid*, No. 18.
Previously analyzed as serial No. 723, crop of 1881.
2137. *Judkin*, collection No. 19.
Previously analyzed as serial No. 730, crop of 1881.
2138. *Blount's Hybrid*, No. 19.
Previously analyzed as serial No. 724, crop of 1881.
2139. *Lost Nation*, collection No. 20.
Previously analyzed as serial No. 741, crop of 1881.
2140. *Blount's Hybrid*, No. 21.
Previously analzyed as serial No. 725, crop of 1881.
2141. *Touselle*, collection No. 21.
Previously analyzed as serial No. 736, crop of 1881.
2142. *Australian Club.*
Previously analyzed as serial No. 731, crop of 1881.
2143. *Blount's Hybrid*, No. 23. Hybrid of two years' standing.
2144. *Blount's Hybrid*, No. 24. " " " " "
2145. *Blount's Hybrid*, No. 25. " " " " "
2146. *Blount's Hybrid*, No. 26, " " " " "
2147. *Blount's Hybrid*, No. 27. " " " " "
2148. *Blount's Hybrid*, No. 28. " " " " "

2149. *Blount's Hybrid*, No. 29. Hybrid of two years' standing.
2150. *Blount's Hybrid*, No. 30. " " " " "
2151. *Blount's Hybrid*, No. 31. " " " " "
2152. *Blount's Hybrid*, No. 33. " " " " "
2153. *Pringle's Hybrid*, No. 6, collection No. 33.
Previously analyzed as serial No. 743, crop of 1881.
2154. *Pringle's Hybrid*, No 7, collection No. 34.
2155. *Blount's Hybrid*, No. 34.
Two years old.
2156. *Blount's Hybrid*, No. 35. Hybrid of two years' standing.
2157. *Blount's Hybrid*, No. 36. " " " " "
2158. *Blount's Hybrid*, No. 37. " " " " "
2159. *Black Bearded Centennial*, collection No. 40.
Previously analyzed as serial No. 727, crop of 1881.
2160. *Hedge Row, White Chaff*, collection No. 41.
Previously analyzed as serial No. 745, crop of 1881.
2161. *Hedge Row, Red Chaff*, collection No. 69.
Previously analyzed as serial No. 746, crop of 1881.
2162. *Fountain*, collection No. 71.
Previously analyzed as serial No. 732, crop of 1881.
2163. *White Chaff*, collection No. 74.
Previously analyzed as serial No. 747, crop of 1881.
2164. *Perfection*, collection No. 76.
Previously analyzed as serial No. 733, crop of 1881.
2165. *Triticum*, collection No. 79.
Previously analyzed as serial No. 748, crop of 1881.
2166. *Russian Durum*, collection No. 81.
Previously analyzed as serial No. 749, crop of 1881.
2167. *Meekin's*, collection No. 88.
Previously analyzed as serial No. 751, crop of 1881.
2168. *German Fife*, collection No. 77.
Previously analyzed as serial No. 737, crop of 1881.
2169. *Prossoc*, collection No. 110.
From California, third crop in Colorado, 1883.
2170. *Prossoc*, collection No. 110.
Second crop in Colorado, 1882.
2171. *Winnipeg Russian*, collection No. 149.
One year old, in Colorado, 1882.
2172. *Winnipeg Russian*, collection No. 149.
Second year's crop in Colorado.
2173. *White Mediterranean*.
Seed received from the Department of Agriculture in 1882.
2174. *White Mediterranean*, collection No. 173.
Product from preceding seed, changed from a winter to a spring wheat. "It will be better next year."
2175. *Red Mediterranean*.
Seed received from the Department of Agriculture in 1882.
2176. *Red Mediterranean*, collection No. 174.
Product from preceding seed.
2177. *French Imperial*.
A spring wheat, distributed by the Department of Agriculture in 1882.
2178. *French Imperial*, collection No. 175.
Product from preceding seed.
2179. *Rust Proof*.
A winter wheat from North Carolina, furnished to Professor Blount.

2180. *Rust Proof*, collection No. 179.
Product from preceding seed, turned to spring.
2181. *Purple Straw.*
A winter wheat from North Carolina.
2182. *Purple Straw*, collection No. 182.
Product of the preceding seed turned to spring.
2183. *Golden Premium.*
A winter wheat from North Carolina "badly mixed."
2184. *Golden Premium*, collection No. 183.
Product from preceding seed. Winter variety changed to spring.
2185. *Hick's Prolific.*
A winter wheat from North Carolina.
2186. *Hick's Prolific*, collection No. 184.
Product from preceding seed. A winter variety changed to spring. "It refused to turn completely, and will require another year."
2187. *Geiger.*
A spring wheat from Northern Asia.
2188. *Geiger*, collection No. 192.
Product from preceding seed.
2189. *Blount's Hybrid*, No. 13.

Grown by W. Brotherton, superintendent of the Ohio Agricultural Experiment Station Farm, Columbus, Ohio, crop of 1883.

2701. *Royal Australian.*
2702. *Treadwell.*
2703. *Champion Amber.*
2704. *McPherson.*
2705. *Clawson.*
2706. *Bearded Treadwell.*
2707. *Valley.*
2708. *Pool.*
2709. *Landreth.*
2710. *Theiss.*
2711. *Michigan Amber.*
2712. *Finley.*
2713. *Zimmerman.*
2714. *Golden Drop.*
2715. *Rocky Mountain.*
2716. *Travis.*
2717. *McGeehee's White.*
2718. *White Velvet.*
2719. *Russian May.*
2720. *Nigger.*
2721. *Wayne's Select.*
2722. *Bennett.*
2723. *Silver Chaff.*
2724. *McGeehee's Red.*
2725. *Lancaster.*
2726. *Rodger's.*
2727. *Red Fultz.*
2728. *Tasmanian.*
2729. *Michigan Bronze.*
2730. *Golden Straw.*
2731. *Velvet Chaff.*
2732. *German Amber.*
2733. *Democrat.*

2734. *York White Chaff.*
2735. *Rice.*
2736. *Mediterranean.*
2737. *Martin's Amber.*
2738. *Fultz.*
2739. *Heighes' Prolific.*
2740. *Grecian.*
2741. *Egyptian.*
2742. *Sandomirka.*

From Centennial Exposition, 1876. *Specimens in Department Museum grown in California.*

2743. *Propo.*
Sperry & Co., San Joaquin County.
2744. *Sonora.*
George Klymer, San Joaquin County.
2745. *Nonpareil.*
William G. Phelps, San Joaquin County.
2746. *Pride of Butte.*
Sperry & Co., San Joaquin County.
2747. *Nonpareil.*
Andrew Wolf, San Joaquin County.
2748. *White Chili.*
Farmers' Union, San Joaquin County.
2749. *White Australian.*
J. Stranzer, San Joaquin County.
2750. *Jones.*
J. Stranzer, San Joaquin County.

Grown in Colorado.

2751. *White Chili.*
W. G. Fowler, Fremont County.
2752. *Colorado Red Chaff.*
W. G. Fowler, Fremont County.

Grown in California.

2753. *Fultz.*
J. Arnold, El Paso County.
2754. *White Colorado.*
R. Gaines, El Paso County.

From Utah.

2756. *Taos.*
Originally from Taos Valley, New Mexico. Grown by C. C. Snow, Hyrum City, Cache County. Crop of 1882.
2757. *Red Taos.*
Grown by Thomas Ord, Nephi, Utah. Crop of 1875.
2758. *Leran.*
Grown by J. W. Shepard, Juab County, 45 bushels to the acre; harvested July 26, 1872.

From Washington Territory.

2759. *Tappahannock.*
Grown by C. B. McFaden, Lewis County, 1871; 62 bushels per acre.

From New Mexico.

2760. *Wheat.*
Raised by Indians in the Taos Valley. From Department of Agriculture Museum.

EXPLANATION OF THE ANALYSES.

In the previous bulletin the analyses included determinations of water, ash, oil, fiber, and albuminoids. During the past year the determinations of oil and fiber have been omitted, as the slight variations which have been found to occur are of less importance in the consideration of the value of the grain, and as the data already obtained are quite sufficient for this purpose. The determination of the albuminoids in connection with the size and condition of the wheat settle, as far as a chemical and physical examination can succeed, the peculiarities of the samples in hand.

THE RESULTS.

The results are presented in the following tables, arranged in the same manner as in previous reports. There is also a table giving such analyses of wheats from other sources as were not included in the previous bulletin.

ANALYSES OF AMERICAN WHEATS, ARRANGED BY STATES.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	PENNSYLVANIA.										
						Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2122	Martin's Amber	Fine	White	Hard	1883		11.30	2.03	73.54	13.13	2.10
	VIRGINIA.										
1851	White Mediterranean	Good	White	Soft	1883	4.255	7.73	2.32	78.92	11.03	1.76
2089	Fultz and Longberry	Fine			1883		9.62	1.93	75.67	12.78	2.04
2112	Osterey	Fair	Yellow	Hard	1883	3.565	9.22	2.50	75.68	12.60	2.02
2113	Red	do	Red	Medium	1883	3.465	9.33	2.15	77.32	11.20	1.79
	WEST VIRGINIA.										
1846	Early Amber	Fair	Amber	Soft	1883		9.42	2.00	77.73	10.85	1.74
1853	Osterey	do	Yellow	Medium	1883	3.392	7.68	2.13	79.16	11.03	1.76
	ALABAMA.										
1847	Dallas	Fair	Yellow	Hard	1882	4.447	9.29	1.79	77.72	11.20	1.79
1848	do	do	do	do	1883	4.277	10.31	1.69	77.67	10.33	1.65
	OHIO.										
2701	Royal Australian	Fair	White	Soft	1883	4.092	10.53	1.80	76.99	10.68	1.71
2702	Treadwell	do	Amber	Medium	1883	3.407	11.16	1.97	75.14	11.73	1.88
2703	Champion Amber	do	do	do	1883	3.268	12.31	2.03	74.48	11.20	1.79
2704	McPherson	do	do	do	1883	3.503	10.65	2.00	75.62	11.73	1.88
2705	Clawson	do	Yellow	Soft	1883	3.300	10.54	1.93	73.70	13.83	2.21
2706	Treadwell, bearded	do	do	do	1883	3.590	9.74	2.30	75.18	12.78	2.04
2707	Valley	do	Amber	Medium	1883	3.250	12.49	1.55	74.06	11.90	1.90
2708	Pool	do	Red	Hard	1883	3.500	10.60	1.90	75.42	12.08	1.93
2709	Landreth	do	White	Soft	1883	3.900	11.82	1.73	75.25	11.20	1.79
2710	Theiss	Shriv'l'd	Red	Hard	1883	2.988	10.95	2.00	73.22	13.83	2.21
2711	Michigan Amber	Fair	Light Red	do	1883	5.800	10.42	2.06	75.79	11.73	1.88
2712	Finley	do	Amber	Medium	1883	3.587	10.00	1.96	74.04	14.00	2.24
2713	Zimmerman	Shriv'l'd	do	do	1883	3.328	11.39	2.04	73.44	13.13	2.10
2714	Golden Drop	Fair	do	do	1883	3.555	11 86	1.74	74.32	12.08	1.93
2715	Rocky Mountains	do	do	do	1883	3.055	9.56	1.77	75.37	13.30	2.13
2716	Travis	Plump	Light Amber	Soft	1883	2.987	10.66	2.20	74.89	12.25	1.99
2717	McGehee's White	Mixed	White	do	1883	3.225	10.68	1.75	74.97	12.60	2.02
2718	White Velvet	do	Amber	do	1883	2.780	10.60	2.06	75.44	11.90	1.90
2719	Russian	do	do	Medium	1883	2.644	9.87	2.09	73.34	14.70	2.35
2720	Nigger	Plump	Red	Hard	1883	4.162	10.67	1.81	76.14	11.38	1.82
2721	Wayne's Select	Mixed	Yellow	Soft	1883	2.663	10.73	1.75	74.22	13.30	2.13

ANALYSES OF AMERICAN WHEATS, ARRANGED BY STATES—CONTINUED.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	OHIO—continued.										
						Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2722	Bennett	Fair	Yellow	Soft	1883	2. 885	10. 69	1. 81	74. 55	12. 95	2. 07
2723	Silver Chaff	do	do	do	1883	3. 270	10. 11	1. 87	76. 29	11. 73	1. 88
2724	McGehee's Red	do	Amber	Medium	1883	3. 288	9. 76	1. 87	74. 02	14. 35	2. 30
2725	Lancaster	do	Light Red	Hard	1883	3. 887	9. 90	2. 15	72. 90	15. 05	2. 41
2726	Rogers	do	Amber	do	1883	3. 108	9. 48	1. 65	75. 39	13. 48	2. 16
2727	Red Fultz	do	Red	do	1883	3. 290	11. 32	2. 05	73. 33	13. 30	2. 13
2728	Tasmanian	do	do	do	1883	3. 581	10. 60	2. 05	73. 70	13. 65	2. 18
2729	Michigan Bronze	do	do	do	1883	4. 093	10. 58	1. 89	76. 85	10. 68	1. 71
2730	Golden Straw	do	Amber	Medium	1883	3. 759	10. 30	2. 00	74. 22	13. 48	2. 16
2731	Velvet Chaff	do	Red	Hard	1883	3. 983	10. 16	2. 10	72. 51	15. 23	2. 44
2732	German Amber	do	do	do	1883	3. 765	9. 75	2. 02	73. 53	14. 70	2. 35
2733	Democrat	Plump	White	Soft	1883	3. 317	10. 03	2. 14	75. 75	12. 08	1. 93
2734	York White Chaff	Mixed	Yellow	do	1883	3. 105	11. 45	1. 90	74. 57	12. 08	1. 93
2735	Rice	do	Amber	Medium	1883	3. 393	11. 36	2. 09	72. 37	14. 18	2. 27
2736	Mediterranean	Plump	do	Hard	1883	3. 940	11. 13	2. 13	70. 64	16. 10	2. 58
2737	Martin's Amber	Fair	White	do	1883	3. 342	11. 32	2. 03	74. 40	12. 25	1. 96
2738	Fultz	do	Light Red	do	1883	3. 505	11. 37	2. 00	73. 50	13. 13	2. 10
2739	Heighes' Prolific	Plump	do	do	1883	3. 378	10. 05	1. 79	74. 68	13. 48	2. 16
2740	Grecian	Mixed	Yellow	Medium	1883	3. 312	10. 95	1. 86	75. 99	11. 20	1. 79
2741	Egyptian	Fair	Amber	do	1883	3. 565	11. 98	1. 76	73. 31	12. 95	2. 07
2742	Sandomirka	do	Light Red	Hard	1883	2. 905	11. 76	1. 88	72. 53	13. 83	2. 21
	ILLINOIS.										
1855		Plump			1883		9. 05	2. 06	76. 46	12. 43	1. 99
	TENNESSEE.										
1850		Fair	Red	Soft	1883		10. 92	2. 32	74. 51	12. 25	1. 96
	ARKANSAS.										
1849	Mediterranean	Fair	Red	Soft	1883		9. 56	2. 52	74. 97	12. 95	2. 07
	MINNESOTA.										
2001	C. A. Pillsbury Mill	Plump	Red	Hard	1883	2. 720	9. 56	1. 91	74. 35	14. 18	2. 27
1868	Polk County	Medium	do	do	1883	2. 780	8. 31	2. 05	75. 29	14. 35	2. 30
2107	Minnesota Hard, No. 1	Plump	do	do	1883	2. 926	8. 05	1. 93	76. 19	13. 83	2. 21
2108	Minnesota Hard, No. 1	Fine	do	do	1883	3. 577	8. 11	1. 76	74. 90	15. 23	2. 44

	DAKOTA.										
1861	Cass County	Plump	do	do	1883	2.841	8.89	1.89	73.12	16.10	2.58
1862	Cass County	do	do	do	1883	2.771	7.71	1.95	74.24	16.10	2.58
1863	Cass County	do	do	do	1883	3.312	7.67	2.10	75.70	14.53	2.32
1864	Cass County	do	do	do	1883	2.802	7.73	1.91	75.13	15.23	2.44
1865	Cass County	do	do	do	1883	3.368	8.48	1.76	72.43	17.33	2.77
1866	Cass County	do	do	do	1883	3.389	8.47	1.96	75.57	14.00	2.24
1867	Cass County	do	do	do	1883	2.921	8.56	2.07	75.02	14.35	2.30
1869	La Moure County	do	do	do	1883	3.700	8.07	1.99	73.66	16.28	2.60
2111	La Moure County	do	do	do	1883	3.074	9.57	1.89	70.51	18.03	2.88
2110	Pembina	do	do	do	1883	3.335	9.92	1.84	75.81	12.43	1.99
	PROVINCES.										
2106	Saskatchiwan	Plump	Red	Hard	1883	3.111	8.85	1.92	73.65	15.58	2.49
2109	Manitoba	do	do	do	1883	3.465	7.84	1.33	77.35	13.48	2.16
	COLORADO.										
2751	White Chili	Plump	Yellow	Soft		3.500	8.23	1.99	79.98	9.80	1.57
2752	Colorado Red Chaff	do	Yellow Amber	Medium		3.478	9.16	2.01	79.03	9.80	1.57
2123	No. 6 Eldorado	do	Yellow	Hard	1883	4.223	9.53	1.95	78.72	9.80	1.57
2124	C No. 8, Defiance	do	do	Soft	1883	3.774	9.79	1.74	77.79	10.68	1.71
2125	Blount's No. 9	do	do	do	1883	4.503	9.53	1.97	78.00	10.50	1.68
2126	Blount's No. 10	do	do	Medium	1883	5.024	8.68	2.26	78.03	11.03	1.76
2127	Collection No. 10, Oregon Club	do	do	Hard	1883	3.714	8.75	2.10	77.77	11.38	1.82
2128	Collection No. 13, White Mexican	do	do	Soft	1883	4.442	8.35	2.20	77.55	11.90	1.90
2129	Collection No. 14, Improved Fife	do	Amber	Hard	1883	3.784	9.28	2.04	74.85	13.83	2.21
2130	Collection No. 15, Russian	do	Red	do	1883	3.808	8.15	2.07	77.53	12.25	1.96
2189	Blount's No. 13	do	do	do	1883	3.699	10.27	2.16	76.89	10.68	1.71
2131	Blount's No. 15	do	do	V. hard	1883	3.572	8.87	2.03	77.37	11.73	1.88
2132	Blount's No. 16	do	Amber	Hard	1883	5.036	8.70	2.13	78.14	11.03	1.76
2133	Sonora collection No. 12	do	Yellow	Soft	1883	3.618	9.12	1.96	76.14	12.78	2.04
2134	Rio Grande collection No. 17	do	Red	Medium	1883	4.162	8.89	2.03	76.13	12.95	2.07
2135	Blount's No. 17	do	do	Hard	1883	4.818	8.90	2.23	74.52	14.35	2.30
2136	Blount's No. 18	do	Amber	do	1883	3.351	9.16	2.10	77.71	11.03	1.76
2137	Collection No. 19, Judkin	do	do	Medium	1883	3.761	9.13	1.91	77.41	11.55	1.85
2138	Blount's No. 19	do	Yellow	Soft	1883	3.442	9.47	1.96	78.59	9.98	1.60
2139	Collection No. 20, Lost Nation	do	Amber	Hard	1883	3.739	9.93	1.87	76.65	11.55	1.85
2140	Blount's No. 21	do	do	Soft	1883	3.543	9.51	1.89	77.75	10.85	1.74
2141	Collection No. 21, Tousselle	do	Yellow	Hard	1883	4.247	10.73	2.12	73.85	13.30	2.13
2142	Collection No. 22, Australian Club	do	do	Medium	1883	4.425	8.97	1.97	78.03	11.03	1.76
2143	Blount's No. 23	do	do	Soft	1883	3.942	9.09	2.31	78.10	10.50	1.68
2144	Blount's No. 24	do	do	do	1883	3.004	9.58	2.07	78.55	9.80	1.57
2145	Blount's No. 25	do	do	Medium	1883	3.873	9.30	2.14	77.71	10.85	1.74
2146	Blount's No. 26	do	do	do	1883	3.987	9.40	2.20	74.02	14 38	2.38
2147	Blount's No. 27	do	do	do	1883	2.645	9.46	1.98	79.63	8.93	1.43
2148	Blount's No. 28	do	do	do	1883	3.827	9.32	2.28	78.42	9.98	1.60
2149	Blount's No. 29	do	do	Hard	1883	2.998	9.33	1.91	79.66	9.10	1.46
2150	Blount's No. 30	do	do	Medium	1883	2.897	9.70	1.81	79.21	9.28	1.48
2151	Blount's No. 31	do	do	do	1883	3.321	10.40	2.19	78.31	9.10	1.46

ANALYSES OF AMERICAN WHEATS, ARRANGED BY STATES—CONTINUED.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	COLORADO—continued.					Grams.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
2152	Blount's No. 33	Plump	Yellow	Hard	1883	2.716	10.15	1.87	79.05	8.93	1.43
2153	Pringle No. 6	do	do	do	1883	4.651	9.30	2.08	74.97	13.65	2.18
2154	Pringle No. 7	do	do	Soft	1883	3.968	9.15	2.05	76.72	12.08	1.93
2155	Blount's No. 34	do	Amber	V. hard, glassy	1883	5.179	8.82	2.43	76.15	12.60	2.02
2156	Blount's No. 35	do	Yellow	Soft	1883	3.055	9.37	2.27	77.86	10.50	1.68
2157	Blount's No. 36	do	Amber	Hard	1883	3.224	9.08	2.00	78.24	10.68	1.71
2158	Blount's No. 37	do	Yellow	Medium	1883	3.559	10.72	2.44	74.94	11.90	1.90
2159	Black Bearded Centennial, Collection No. 40	do	do	Hard	1883	5.578	8.60	2.10	77.45	11.85	1.85
2160	Collection No. 41, Hedge Row, White Chaff	do	do	Soft	1883	2.838	9.16	2.02	77.09	11.73	1.88
2161	Collection No. 69, Hedge Row, Red Chaff	do	do	Medium	1883	4.008	9.18	2.19	75.68	12.95	2.07
2162	Collection No. 71, Fountain	do	do	Soft	1883	4.191	8.27	2.14	77.69	11.90	1.90
2163	Collection No. 74, White Chaff	do	Red	Hard	1883	3.252	7.95	2.05	77.92	12.08	1.93
2164	Collection No. 76, Perfection	do	Yellow	do	1883	5.032	10.29	2.08	74.68	12.95	2.07
2165	Collection No. 79, Traticum	do	do	do	1883	4.861	8.98	2.02	75.00	14.00	2.24
2166	Collection No. 81, Russian Duram	do	do	Medium	1883	4.761	8.70	2.10	74.85	14.35	2.30
2167	Collection No. 88, Mukin's	do	Red	do	1883	4.414	10.15	2.05	74.32	13.48	2.16
2168	Collection No. 77, German Fife	do	Amber	Soft	1883	4.546	10.05	2.28	75.07	12.60	2.02
2169	Collection No. 110, Product of 1883, Prossoe, three years old.	do	Yellow	do	1883	4.275	8.85	2.38	75.47	13.30	2.13
2170	Collection No. 110, Product of 1882, Prossoe, three years old.	do	do	do	1882	4.654	9.62	2.52	75.78	12.08	1.93
2171	Collection No. 149, product of 1882, winter	do	Amber	Medium	1882	3.438	8.92	2.31	75.99	12.78	2.04
2172	Collection No. 149, product of 1883, winter, two years old.	do	do	Soft	1883	3.985	9.68	2.14	75.93	12.25	1.96
2174	Collection No. 173, White Mediterranean, product to spring, 1883.	do	Yellow	do	1883	4.182	9.69	2.19	76.92	11.20	1.79
2176	Collection No. 174, Red Mediterranean, product to spring, 1883.	do	Amber	V. hard	1883	3.650	9.50	2.10	74.75	13.65	2.18
2178	Collection No. 175, French Imperial, winter to spring, 1883.	do	do	Medium	1883	4.594	9.55	1.95	75.55	12.95	2.07
2180	Collection No. 179, Rust Proof, product to spring, 1883.	do	do	Soft	1883	4.957	10.25	2.10	75.22	12.43	1.99
2182	Collection No. 182, Purple Straw, product winter to spring.	do	do	do	1883	3.231	11.11	2.04	74.25	12.60	2.02
2184	Collection No. 183, Golden Premium, product winter to spring.	do	Yellow	Medium	1883	3.818	9.44	2.17	77.01	11.38	1.82
2186	Collection No. 184, Hick's Prolific product	do	Amber	Soft	1883	2.879	9.21	2.04	78.42	10.33	1.65
2188	Collection No. 192, Geiger product	do	Yellow	Medium	1883	4.064	9.92	2.20	73.35	14.53	2.32
	UTAH.										
2757	Red Taos	Fair	Yellow	Soft	1875	4.084	9.27	1.93	78.30	10.50	1.68
2758	Leran	do	do	do	1875	3.703	9.07	2.53	D 78.60	9.80	1.57

	NEW MEXICO.											
2756	Taos	Fair	Yellow	Soft	1882	3.188	9.50	2.10	76.67	11.73	1.88
2760	German	do	do		1875	3.956	9.10	1.77	79.85	9.28	1.47
2743	Propo	Good	do	Soft	1875	3.616	11.37	1.87	74.68	12.08	1.93
2744	Sonora	do	do	do	1875	3.320	11.40	2.02	76.43	10.15	1.62
2745	Nonpareil	do	do	do	1875	5.184	11.82	1.79	75.19	11.20	1.79
2746	Pride of Butte	do	do	do	1875	3.445	11.18	1.90	76.94	9.98	1.60
2747	Nonpareil	do	do	do	1875	3.905	10.82	1.93	74.47	12.78	2.04
2748	White Chili	do	do	do	1875	4.163	10.47	1.95	75.68	11.90	1.90
2749	White Australian	do	do	do	1875	5.042	10.38	2.02	78.50	9.10	1.46
2750	Jones	do	do	do	1875	3.611	10.16	1.68	78.71	9.45	1.51
2753	Fultz	do	Red	Hard	1875	3.095	10.20	1.49	76.06	12.25	1.96
2754	White Colorado	do	Yellow	Soft	1875	3.543	9.53	1.97	78.00	10.50	1.68
	WASHINGTON TERRITORY.										
1854	Walla Walla	Fine	White	Soft	1883	2.584	10.13	1.95	80.22	7.70	1.23
2759	Tappahanock	do	Yellow	Glossy	1871	4.726	9.65	2.02	79.58	8.75	1.40

CONCLUSIONS DERIVED FROM THE DATA.

The analyses in the preceding tables when combined with those previously published modify to a certain immaterial degree the average composition of the wheat of the whole country. The few scattered analyses from the Eastern States change the averages for those States very slightly, the greater number of specimens coming from Ohio, Minnesota, Dakota, and California, localities which were not represented before, or at most indifferently well; and from Colorado, where wheats from the same farm have been examined for three consecutive years.

OHIO.

The wheats from this State were grown on the farm of the Ohio State University, near Columbus, Ohio. A number of them were the result of experiments on the yield and other qualities of the grain, which have been carried on by the farm superintendent, Mr. W. Brotherton, for three years.

The crop of 1883 averaged, it is said, about 30 bushels per acre. It was not, however, entirely plump, "owing to a wet spring succeeded by dry weather before ripening," and the weight per bushel was therefore light, about 57 pounds. The fact that the grain was shriveled was very likely due to a lack of ability to fill the floury portion with its full quantity of starch, and the relative percentage of nitrogen is therefore higher than would be found in a well-developed grain.

From the data derived from the experiments above mentioned, the following averages have been published by Mr. Brotherton:

Average yield per acre, crop of 1883.

Grain	bushels..	39.33
Straw	pounds..	4727.
Pounds straw to bushel of wheat		120.1
Weight of wheat per bushel	pounds..	56.6

Average yield and weight of red wheat, compared with white wheat.

	Average yield.			Average weight.		
	1881.	1882.	1883.	1881.*	1882.*	1883.†
	Bushels.	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
Red	21.6	24.1	38.9	60.1	57.9	57.5
White	20.8	24.6	35.5	60.0	59.5	55.6

Average yield and weight of smooth wheat, compared with bearded wheat.

	Average yield.			Average weight.		
	1881.	1882.	1883.	1881.*	1882.*	1883.†
	Bushels.	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
Smooth	20.2	23.5	37.6	59.7	59.2	56.9
Bearded	22.5	24.6	42.7	60.7	59.5	57.4

* As cleaned for seed. † As from machine.

The red varieties and the bearded wheats seem to possess a trifling advantage in Ohio, at least for the years during which the experiments were carried on.

MINNESOTA.

The specimens previously analyzed from this State were from the exhibits of the Saint Paul, Minneapolis and Manitoba Railroad in the Department Museum, but as they were not considered representative wheats by prominent millers, and the results were unsatisfactory to them, they were invited to send samples of their own selection from the crop of 1883. The analyses given in this bulletin will, therefore, show the composition of the best spring wheat of Minnesota, but it can hardly be said to represent the average of the State, as the samples were all of No. 1 hard wheat.

The average of the analyses previously published, of the four made this year and of all taken together, are given below:

	Railroad exhibits, &c.	No. 1 hard wheat, 1883.	All.
Number of analyses	9.	4.	13.
Weight of 100 grains ......grams..	3. 354	3. 001	3. 168
Water ......per cent..	10. 60	8. 64	9. 96
Ash ......do....	1. 71	1. 91	1. 77
Undetermined ......do...	75. 03	75. 05	75. 09
Albuminoids ......do....	12. 66	14. 40	13. 18
	100. 00	100. 00	100. 00
Nitrogen ......do.....	2. 03	2. 31	2. 11

The average of all probably fairly represents the production of the State, while "No. 1 hard spring wheat" is richer in albuminoids, but small in size, both of which characteristics may be due to a lack of starch, owing to the short period of growth and rapid maturity and consequent inability to assimilate as much of the carbohydrates as the winter wheats.

This point is well illustrated by two wheats from Dakota, analyses of which were published in our previous report, one of which was a winter wheat and the other spring. The weights of one hundred grains were—

	Grams.
Winter	3. 513
Spring	2. 755

and the percentages of albuminoids—

Winter	10. 68
Spring	14. 35

the latter being in inverse proportion to the former, so that if the winter wheat were supposed to be diminished in size at the expense of its starch the relative percentage of nitrogen would rise to a point near that usually found in spring wheats.

In another portion of this report the flours and mill products from the spring wheats of Minnesota will be discussed.

DAKOTA.

The only two specimens of Dakota wheat which have hitherto been analyzed are those of which mention has just been made.

Through the kindness of General M. V. Z. Woodhull, specimens of the crop of spring wheat of 1883 from some of the leading farms of the Territory have been sent to this Division. As will be seen, they are all extremely rich in albuminoids with the exception of that grown in Pembina. One specimen contains 18.03 per cent. of albuminoids, and the ten together average over 15 per cent.

Average composition of Dakota spring wheat, crop of 1883.

Weight of 100 grains	grams..	3.151
Water	per cent..	8.51
Ash	do....	1.94
Undetermined	do....	74.11
Albuminoids	do....	15.44
		100.00
Nitrogen	do....	2.47

The wheat containing 18.03 per cent. of albuminoids is the richest which has yet been analyzed in the United States. It was grown in Lamoure County by Sykes & Hughes; and is, of course, a spring variety. It would be interesting to observe the composition of a winter wheat grown on that soil, the only winter specimen which has been analyzed having, as has been said, a small percentage of albuminoids

With the modern methods of milling, hard wheats of the description which have been analyzed are very desirable, and Dakota and Minnesota with their large supplies of grain, rich in nitrogenous constituents, will necessarily produce some of the finest flours in the country, more nearly approaching the Hungarian than any other.

COLORADO.

In the previous bulletin the analyses were published of a large number of wheats from Colorado, grown during the years 1881 and 1882 by Prof. A. E. Blount, of the agricultural college, at Fort Collins.

The average composition for each year was as follows:

Average composition of Colorado wheat, crops of 1881 and 1882.

		1881.	1882.
Number of varieties analyzed		33	12
Weight of 100 grains	grams..	4.865	4.283
Water	per cent..	9.86	8.80
Ash	do...	2.28	1.99
Oil	do..	2.41	2.38
Carbhydrates	do...	70.48	72.08
Crude fiber	do..	1.57	1.76
Albuminoids	do..	13.40	13.04
		100.00	100.00
Nitrogen	do...	2.14	2.09

Or for the two seasons:

Average composition of Colorado wheats for the two seasons, 1881–'82.

Number of varieties analyzed		45
Weight of 100 grains	grams..	4.682
Water	per cent..	9.57
Ash	do....	2.21
Oil	do....	2.38
Carbhydrates	do....	70.91
Crude fiber	do....	1.62
Albuminoids	do....	13.31
		100.00
Nitrogen	do....	2.13

Specimens of the crop of 1883 have been examined, and the average for that year obtained.

Average composition of Colorado wheat, crop of 1883.

Number of varieties analyzed		57
Weight of 100 grains	grams..	3.941
Water	per cent..	9.38
Ash	do....	2.09
Undetermined	do....	76.79
Albuminoids	do....	11.74
		100.00
Nitrogen	do....	1.88

It is plain that there has been a very marked falling off in albuminoids. Twenty-eight of the fifty-seven varieties examined this year were also among the specimens of 1881. The averages for the two years of the same varieties show in the same way changes such as were seen in the average of all.

Average composition of twenty-seven Colorado wheats in 1881 *and in* 1833.

		1881.	1883.
Weight of 100 grains	grams..	4.947	4.197
Water	per cent..	9.83	9.15
Ash	do....	2.23	2.00
Undetermined	do....	74.52	76.66
Albuminoids	do....	13.42	12.19
		100.00	100.00
Nitrogen	do....	2.15	1.95

There has been a falling off in ash and albuminoids, and in the weight of 100 grains, and the uniformity of the change in these respects is shown by a comparison of each analysis in this regard.

Comparison of the crops of 1881 *and* 1883.

Serial number.	Weight of 100 grains.		Water.		Ash.		Albuminoids.		Nitrogen.	
	1881.	1883.	1881.	1883.	1881.	1883.	1881.	1883.	1881.	1883.
	Grams.	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
728	4.702		10.55		2.24		11.75		1.88	
2123		4.223		9.53		1.95		9.80		1.57
719			9.72		2.28		13.75		2.20	
2126		5.024		8.68		2.26		11.03		1.76
738	4.434		9.59		1.91		12.25		1.96	
2127		3.714		8.75		2.10		11.38		1.82
729			9.91		2.60		13.81		2.21	
2128		4.442		8.35		2.20		11.90		1.90
734	4.131		9.55		1.99		14.49		2.31	
2130		3.808		8.15		2.07		12.25		1.96
720			10.07		1.03		12.25		1.96	
2131		3.572		8.87		2.03		11.73		1.88
721	4.824		9.53		2.04		11.75		1.88	
2132		5.036		8.70		2.13		11.03		1.76
739	4.739		10.17		2.02		14.18		2.27	
2133		3.618		9.12		1.96		12.78		2.04
735	5.906		9.51		2.08		14.69		2.35	
2134		4.162		8.89		2.03		12.95		2.07
722	5.137		9.93		2.07		13.62		2.18	
2135		4.818		8.90		2.23		14.35		2.30
723			9.74		2.19		12.94		2.07	
2136		3.351		9.16		2.10		11.03		1.76
730			9.75		2.57		12.25		1.96	
2137		3.761		9.73		1.91		11.55		1.87
724			10.55		2.54		12.44		1.99	
2138		3.442		9.47		1.96		9.98		1.60
741	3.851		10.24		2.17		12.93		2.07	
2139		3.739		9.93		1.87		11.55		1.85
736	5.214		10.23		2.10		13.50		2.16	
2141		4.247		10.73		2.12		13.30		2.13
731	5.506		9.78		1.85		11.19		1.79	
2142		4.425		8.97		1.97		11.03		1.76
742	5.145		9.89		2.13		13.13		2.10	
2153		4.651		9.30		2.08		13.65		2.18
743	4.636		9.89		2.23		15.25		2.44	
2154		3.968		9.15		2.05		12.08		1.93
727			9.66		2.35		12.06		1.93	
2159		5.578		8.60		2.10		11.85		1.85
745	4.072		9.07		2.08		13.62		2.18	
2160		2.838		9.16		2.02		11.73		1.88
746	4.499		9.17		2.59		12.94		2.07	
2161		4.208		9.18		2.19		12.95		2.07
732	5.100		10.58		2.70		13.62		2.18	
2162		4.191		8.27		2.14		11.90		1.90
747	4.214		9.57		2.03		14.04		2.25	
2163		3.252		7.95		2.05		12.08		1.93
733	5.536		9.93		1.99		14.18		2.27	
2164		5.032		10.29		2.08		12.95		2.07
748	5.754		10.02		2.67		13.62		2.18	
2165		4.861		8.98		2.02		14.00		2.24
749	5.924		9.91		2.32		15.25		2.44	
2166		4.761		8.70		2.10		14.35		2.30
751	5.193		9.38		2.53		15.15		2.43	
2167		4.414		10.15		2.05		13.48		2.16
737	5.368		10.42		2.31		15.06		2.41	
2168		4.546		10.05		2.28		12.60		2.02

There was a loss of albuminoids in every variety, with four exceptions, and a decrease in weight in all but one. This change, which at first seemed rather surprising, is explained by Professor Blount in the following letter:

COLORADO AGRICULTURAL COLLEGE,
Fort Collins, Colo., June 17, 1884.

MY DEAR SIR: Your letter of the 11th, inclosing analyses of wheats, received. I am not at all surprised at the falling off in the albuminoids and other deleterious changes. I think I can give a satisfactory reason for the deterioration.

First. In June of last year, while these wheats were in the formation stage, we had a heavy and destructive hail-storm, which almost entirely destroyed my whole crop. So badly was it beaten down that it was a month before the crop was where it was before, and not half of it then was making anything like good grain. I find when the wheat plant is in any way injured the grain especially suffers most. The foliage, if anything, rather flourishes, or, in other words, grows more vigorously and rank. The sap is more abundant, and the grain producing elements much less.

Second. Last year up to August we had much more rain than ever before. Frequent showers, followed by hot suns and damp, sultry air, made many of my wheats rust. Those injured and put back by hail suffered most from rust.

I am satisfied these are the causes of deterioration noticed in the analyses. The difference in the two seasons was as great as that between ours generally and that of Iowa. I think this year will bring out my hybrids with a better showing.

Very truly, yours,

A. E. BLOUNT.

CLIFFORD RICHARDSON, Esq.,
Assistant Chemist.

Professor Blount's conclusions are interesting and undoubtedly correct, and show how sensitive wheat is to causes affecting its development.

Arrested development may apparently produce two results, according to the period in the growth of the plant at which it occurs. In the Colorado specimens, as Professor Blount remarks, the supply of nitrogen was probably cut off by the injury done by storms. In the cases of the Ohio wheats, which owed their small size and shriveled appearance to wet weather just before harvesting, the check to development came after the nitrogenous portion of the seed had been stored up and prevented the accumulation of the starch which was necessary to make a plump grain.

Professor Blount proposes to continue his experiments, and it will be very interesting to observe the quality and composition of succeeding crops.

In 1882 the product of several seed wheats sent to Colorado in 1881 was found to be much richer in albuminoids than the original seed and in our previous bulletin attention was called to this fact. Of the last year's crop eight varieties were from seed sent to Professor Blount from Washington.

A comparison of the analyses will show the changes during the past unfavorable season.

Comparison of Department seed and Colorado crops, 1882-'83.

Serial number.	Weight of 100 grains.		Water.		Ash.		Albuminoids.		Nitrogen.	
	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.
	Grams.	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2173	4.152		9.84		1.73		9.98		1.60	
2174		4.182		9.69		2.19		11.20		1.79
2175	3.650		9.40		1.94		11.73		1.88	
2176		3.650		9.50		2.10		13.65		2.18
2177	2.820		9.74		1.94		12.60		2.02	
2178		4.594		9.55		1.95		12.95		2.07
2179	4.336		9.90		1.86		10.33		1.65	
2180		4.957		10.25		2.10		12.43		1.99
2181	2.612		11.35		1.75		12.60		2.02	
2182		3.231		11.11		2.04		12.60		2.02
2183	4.084		10.50		1.95		9.80		1.57	
2184		3.818		9.44		2.17		11.38		1.82
2185	3.062		10.38		1.89		10.15		1.62	
2186		2.879		9,21		2.04		10.33		1.65
2187	3.138		9.48		2.56		16.45		2.63	
2188		4.064		9.92		2.20		14.53		2.32
Average	3.482	3.922	10.07	9.83	1.95	2.10	11.71	12.38	1.88	1.98
Gain		6		3		7		7		7
Loss		2		5		1		1		1

The averages show that the crop, notwithstanding unfavorable conditions, has improved in ash and albuminoids and size of the grain, and that the conclusions of previous analyses are verified. The last variety, No. 2187-8, was the only one to lose in percentage of albuminoids, and this was plainly because it contained in the seed a higher amount than could be supported by Colorado conditions in the crop.* This same wheat, the Geiger, a spring variety from Asia, it will be noticed contains a large amount of ash in connection with its high percentage of albuminoids, and loses the one with the decrease of the other. Attention has already been drawn to the intimate relation between ash and albuminoids in the whole grain in the previous report, and the reason of this will appear in later analyses where it is shown that the bran and germ, both storehouses of nitrogen, contain large amounts of ash.

That Colorado is a place where a rich and fine wheat can be raised is evident from the work of the past three years; but it is also plain that all the aid which human agency can control must be given to this end. Two samples of wheat grown in another part of the State, Fremont County, which have been in the Department Museum for some time, are not rich in albuminoids, containing each only 9.80 per cent. This variation shows that great care is always necessary to keep the grain at a high standard and that in the case of the wheats from Fremont County something was lacking.

THE PACIFIC COAST.

The conclusion was drawn from analyses completed last year that Oregon produced a wheat extremely poor in albuminoids, although the

*See Bulletin No. 1, p. 43.

appearance of the grain was fair and large; and it was surmised that grain from the whole Pacific slope might possess the same peculiarity. Surprise having been expressed at this statement, it was suggested that an analysis should be made of a selected sample of Oregon wheat, of the crop of 1883. For this purpose a specimen was chosen which the Northern Pacific Railroad presented to its guests at a dinner in Walla Walla, during the excursion given by the road in the autumn of 1883. The result (serial No. 1854) was a complete confirmation of previous analyses. The percentage of albuminoids found was 7.70, and this determination having been confirmed by duplication, the wheat was proved to be the lowest in albuminoids of any that have been examined in this country. Its appearance was fine, but the size of the grain smaller than one usually expects in Oregon wheats. Further on it will be seen that this peculiarity of poverty in albuminoids among Oregon wheats is confirmed by the analysis of a new process flour made in that State which was found to contain only 7.18 per cent.

All attempts to obtain typical samples of the crops of 1883 from California having failed it was necessary to fall back upon a series of wheats from that State in the Museum of this Department, which were of the crops of 1875 and were exhibited at the Exhibition at Philadelphia. While more recent specimens would be more desirable, there can have been no changes in the amount of nitrogenous constituents, the chief alteration of the grain being in the amount of water which it would contain.

The average derived from the ten analyses follows:

Average composition of California wheat from San Joaquin, Contra Costa, and El Paso Counties.

Wheat of 100 grains	grams..	3.8924
Water	per cent..	10.73
Ash	do....	1.86
Undetermined	do....	76.47
Albuminoids	do....	10.94
Total		100.00
Nitrogen	per cent..	1.75

This average is not as low as that for Oregon, but is far below (1 per cent.) the average of the country. It represents but a limited portion of the State, and while it points to the correctness of the assumption of the poverty of the wheats of the Pacific slope in albuminoids it does not render it positive, as several of the specimens contain over 12 per cent.

In the report of the Census for 1880, Professor Brewer, in his collection of analyses of cereals, gives four of California wheat, two of which, described as hard, are the celebrated Macaroni wheats and contain

13.76 and 12.84 per cent. of albuminoids, and two are white wheats containing only 8.25 and 9.69 per cent. From these results it would seem that the hard wheats are more able to collect nitrogen than the soft white varieties, and as the specimens from Oregon have been all of the latter kind, the low percentage of nitrogen may be due to that fact. It would be of interest to examine a hard red wheat grown in that State.

ADDITIONAL ANALYSES.

Allusion has been made to the collection of analyses of cereals by Professor Brewer in his report to the Census of 1880.* Such of the wheat analyses as have not been inserted in the previous bulletin are here published for the purpose of presenting, as a whole, all analyses which have been made of American specimens.

*Tenth Census of the United States, Vol. III, Statistics of Agriculture, p. 414.

ANALYSES OF WHEATS FROM OTHER SOURCES THAN THE DEPARTMENT OF AGRICULTURE.

Name.	Locality.	Year.	Spring or winter.	Water.	Ash.	Fat.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Analyst.
				Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Amber-bearded	Maine		Spring	13.35	1.79	2.00	69.06	1.99	11.81	1.89	U. S. Census.
White Winter	New York		Winter	13.07	1.63	1.65	71.23	1.79	10.63	1.70	Do.
Red Winter	do		do	13.30	1.70	1.59	68.08	1.73	13.60	2.18	Do.
From limestone land	New Jersey		do	13.30	2.09	1.70	69.62	1.90	11.39	1.82	Do.
From gray rock, gravel soil	do		do	13.67	1.82	1.74	68.34	1.93	12.50	2.00	Do.
No 1 white winter	Michigan		do	12.89	1.85	1.56	70.74	1.90	11.06	1.77	Do.
Fultz	Wisconsin		do	12.34	1.89	1.62	71.30	1.76	11.09	1.77	Do.
Red Mammoth	do		Spring	12.13	2.30	2.07	66.07	2.30	15.13	2.42	Do.
Spring wheat	Minnesota		do	11.13	1.95		*72.92		14.00	2.24	Kedzie.
Scotch Fife	Dakota		do	12.60	1.98	1.82	68.09	2.01	13.50	2.16	U. S. Census.
Scotch Fife	do		do	12.90	1.77	1.82	68.33	1.93	13.25	2.12	Do.
Macaroni	California	1879	Winter	10.70	1.97	1.46	70.21	1.90	13.76	2.20	Do.
Macaroni	do	1879	do	10.93	1.45	1.63	71.40	1.75	12.84	2.05	Do.
White Club	do	1879	do	11.23	1.93	1.67	74.78	2.14	8.25	1.32	Do.
No. 1, San Francisco Produce Exchange	do	1879	do	11.03	1.78	1.77	73.58	2.15	9.69	1.55	Do.

* Fiber, carbhydrates, and fat.

AVERAGES.

The analyses completed during the past year numbered one hundred and forty-seven, the specimens being divided among different portions of the country as follows:

Eastern and Gulf States	9
Middle States	44
Western States	80
Pacific States	12
British Provinces	2

Averages derived from the results of these analyses are here given, and also those obtained by a combination of all results up to this time:

AVERAGES FROM THE ANALYSES OF 1883-'84.

Locality.	Number of analyses.	Number of weights.	Weight of 100 grains.	Water.	Ash.	Undetermined.*	Albuminoids.	Nitrogen.	Weights.		Albuminoids.	
									Highest.	Lowest.	Highest.	Lowest.
			Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Per cent.*	*Per cent.*
United States and British Provinces	147	142	3.653	9.97	2.06	77.44	10.53	2.01	5.800	2.584	18.03	7.70
Atlantic States	9	6	3.900	11.54	2.06	74.83	11.57	1.85	4.447	3.465	12.78	10.33
Middle States	44	42	3.458	10.71	1.95	74.48	12.86	2.06	5.800	2.663	16.10	10.68
Western States	80	80	3.717	9.58	2.16	75.55	12.71	2.03	5.578	2.716	18.03	8.93
Manitoba	2	2	3.288	8.34	1.63	75.50	14.53	2.32	3.465	3.111	15.58	13.48
Pacific States	12	12	3.853	10.59	1.88	77.04	10.49	1.68	5.184	2.584	12.78	7.70
Pennsylvania	1			11.30	2.03	73.54	13.13	2.10				
Virginia	4	3	3.762	8.98	2.22	76.90	11.90	1.90	4.255	3.465	12.78	11.03
West Virginia	2	1	3.392	8.55	2.07	78.44	10.94	1.75			11.03	10.85
Alabama	2	2	4.362	9.80	1.74	77.70	10.76	1.72	4.447	4.247	11.20	10.33
Ohio	42	42	3.458	10.74	1.94	74.43	12.89	2.06	5.800	2.663	16.10	10.68
Illinois	1			9.05	2.06	76.46	12.43	1.99				
Tennessee	1			10.92	2.32	74.51	12.25	1.96				
Arkansas	1			9.56	2.52	74.97	12.95	2.07				
Minnesota	4	4	3.001	8.51	1.91	75.19	14.39	2.31	3.577	2.720	15.23	13.83
Dakota	10	10	3.151	8.51	1.94	74.11	15.44	2.47	3.700	2.771	18.03	12.43
Manitoba	2	2	3.288	8.35	1.63	75.49	14.53	2.33	3.465	3.111	15.58	13.48
Colorado	61	61	3.931	9.85	2.21	75.63	12.31	1.97	5.578	2.716	14.53	8.93
Utah	2	2	3.893	9.17	2.23	78.45	10.15	1.62	4.084	3.703	10.50	9.80
New Mexico	2	2	3.572	9.30	1.98	78.22	10.50	1.68	3.956	3.188	11.73	9.28
California	10	10	3.892	10.73	1.86	76.47	10.94	1.75	5.184	3.095	12.78	9.10
Washington Territory	2	2	3.655	9.89	1.98	79.90	8.23	1.32	4.726	2.584	8.75	7.70

* Fiber, carbhydrates, and fat.

AVERAGE COMPOSITION OF AMERICAN WHEATS.

Locality.	Number of analyses.	Number of weights.	Weight of 100 grains.	Water.	Ash.	Undetermined.*	Albuminoids.	Nitrogen.	Weight of 100 grains.		Albuminoids.	
									Highest.	Lowest.	Highest.	Lowest.
			Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Per cent.*	*Per cent.*
United States and British America	407	377	3.644	10.16	1.92	75.77	12.15	1.94	5.924	1.830	18.03	7.70
Atlantic and Gulf States	117	105	3.489	10.34	1.77	76.54	11.35	1.81	5.079	1.830	15.58	9.43
Middle States	91	89	3.537	10.61	1.85	75.04	12.50	2.00	5.800	2.138	16.63	10.15
Western States	177	166	3.763	9.83	2.06	75.37	12.74	2.04	5.924	2.561	18.03	8.93
Pacific States	20	15	4.091	10.25	1.87	78.15	9.73	1.56	5.745	2.584	12.78	7.70
Canada	6	....	3.325	9.74	1.56	77.83	10.87	1.74	3.686	2.964	14.70	9.45
Pennsylvania	33	26	3.373	10.73	1.70	76.13	11.44	1.83	4.658	2.035	15.58	9.45
Maryland	9	....	3.597	10.52	1.75	76.08	11.65	1.86	5.079	3.075	14.53	9.80
Virginia	15	14	3.433	9.98	1.84	76.08	12.10	1.93	4.283	1.830	14.00	10.15
West Virginia	2	1	3.392	8.55	2.07	78.44	10.94	1.75	....	....	11.03	10.85
North Carolina	22	....	3.776	10.03	1.59	77.95	10.43	1.67	4.628	2.780	12.43	8.93
Georgia	7	....	3.579	10.00	1.96	76.26	11.78	1.89	4.627	2.834	14.00	9.45
Alabama	19	19	3.424	10.82	1.96	75.93	11.29	1.80	4.647	2.011	13.65	9.80
Ohio	44	44	3.476	10.68	1.94	74.55	12.83	2.05	5.800	2.663	16.10	10.68
Tennessee	15	14	3.150	10.24	1.92	75.34	12.50	2.00	3.990	2.138	16.63	10.15
Kentucky	8	....	3.454	10.83	1.75	74.27	13.15	2.10	3.666	3.146	14.53	11.90
Michigan	22	....	3.969	10.71	1.64	75.98	11.67	1.87	4.902	3.402	15.23	10.50
Missouri	12	....	3.502	9.80	1.92	76.72	11.56	1.86	3.867	3.098	14.00	10.50
Arkansas	1	....	....	9.56	2.52	74.97	12.95	2.07	....	....	....	....
Minnesota	13	13	3.245	9.96	1.77	75.08	13.19	2.11	3.867	2.720	17.15	10.85
Dakota	12	12	3.149	8.84	1.96	74.25	14.95	2.40	3.700	2.771	18.03	12.43
Manitoba	2	2	3.288	8.35	1.63	75.49	14.53	2.32	....	....	....	....
Kansas	10	....	3.204	11.80	1.64	75.41	11.15	1.78	3.424	2.881	12.25	10.50
Texas	19	....	2.847	10.03	1.81	75.02	13.14	2.10	3.937	2.561	15.23	10.68
Colorado	106	98	4.214	9.73	2.21	75.33	12.73	2.03	5.924	2.716	15.94	8.93
Utah	2	2	3.893	9.17	2.23	78.45	10.15	1.62	4.084	3.703	10.50	9.80
New Mexico	2	2	3.572	9.30	1.98	78.22	10.50	1.68	3.956	3.188	11.73	9.28
California	10	10	3.892	10.73	1.86	76.47	10.94	1.75	5.184	3.095	12.78	9.10
Oregon	8	....	5.044	9.74	1.84	79.82	8.60	1.37	5.745	4.253	9.47	8.05
Washington Territory	2	2	3.655	9.89	1.98	79.90	8.23	1.32	4.726	2.584	8.75	7.70

*Fiber, carbhydrates, and fat.

Owing to the fact that the wheats were this year nearly all from the Middle States and the West, they average more nearly the composition shown previously for the Western country.

Colorado has fallen off somewhat, owing to its poor crop, but the high percentage of albuminoids in the Ohio samples has counteracted this result, and the general average for the whole country, derived from the 407 samples analyzed, is somewhat higher than last year.

The general conclusions of the previous bulletin are, however, not essentially altered.

CHEMISTRY OF THE ROLLER MILLING PROCESS OF GRADUAL REDUCTION.

It is the object of milling to reduce the floury portion of the wheat-grain to the finest possible form without injuring its physical condition, and at the same time with complete exclusion of portions of the bran and germ, and such refuse products as would injure its baking qualities and color. An examination of the structure of the grain will enable us to understand the difficulties to be met and the way in which the different products which have been analyzed are obtained.

If a blade of wheat were much thickened and the two halves then folded back upon themselves a transverse section of it would represent a similar section of the grain, that is to say the two lobes would meet, forming what is known in the grain as the crease within which would be inclosed and hidden a portion of the outer covering. This explains how difficult it is in preparing the wheat for milling to remove all the foreign matter which this crease contains. On the exterior of the grain there is found toward one end a collection of hair, and at the other end appears the embryo or germ. A longitudinal section shows both of these undesirable additions to the floury matter of the grain. Aside from its exterior appearance the wheat-grain is essentially an embryo, the germ, together with a supply of food, the endosperm or floury matter, surrounded by several membranes or coats of greater or less importance. On the exterior is the first membrane or *cuticle*, a very thin coating, easily removed by rubbing. Next follows a more important, because thicker, portion of the outer covering, consisting of two layers of cellular tissue, the *epicarp* and *endocarp*. These three membranes together form the outer covering of the grain, and from one of them, the epicarp, spring the hairs which are found on one end. These envelopes are colorless and very light, constituting only from 3 to 3½ per cent. of the whole, and are more or less easily removed by friction. From an examination of a section of the grain it is seen that within the crease this is of course impossible, so that while the preparation of the wheat for milling may remove the hairs and much of the cuticle and dirt it cannot completely free it from them. It is this inherent difficulty that the roller mills attempt to overcome by splitting the grain along the crease and afterwards cleaning it with brushes.

Under these outer coverings are three membranes, known as the *testa* or *episperm*, the *tegmen*, and the *embryous envelope*. The testa is a compact affair, and carries the coloring matter of the bran. The tegmen is an extremely thin membrane not easily seen except where it becomes thick and just under the testa in the heart of the crease. It is not of importance from a milling point of view. The testa and tegmen form about 2 per cent. of the grain.

The *embryous membrane* is a continuation of the embryo around the endosperm or floury portion of the grain. It is composed of cells which are often erroneously termed gluten cells, but the true gluten cells are scattered through the endosperm. The cells of the embryous membrane contain little or no gluten, and as they are a continuation of the embryo it must be nearly as undesirable to allow them in the finished flour as the germ itself.

The endosperm is by far the largest portion of the grain, and it is that which is the object of all milling processes to separate from the rest of the wheat and grind to flour.

It consists of large cells containing the granules of starch and the gluten. At the exterior, nearer the embryous membrane, it is much harder than in the center and contains much more gluten. In all methods of gradual reduction, therefore, the center is of course reduced first, and, being very starchy, is only fit for a low-grade flour, while the richest part of the endosperm, being harder and closely attached to the tough bran coats, is to a certain extent lost, or so contaminated with small pieces of the bran as to injure the color of the flour, furnishing what is known as bakers' grades.

By the old-fashioned low-milling process, or grinding between stones placed very close together and bolting, it was impossible to obtain a flour entirely free from contamination. The advance to high milling with stones far apart, allowing the middlings which were produced to be purified before grinding to flour, was a step which made it possible to make from winter wheat an excellent and pure flour. When, however, spring wheat, with its hard and brittle outer coats, became important commercially, it was necessary to resort to the roller methods of milling, which, in conjunction with peculiar purifying machinery, would furnish a flour free from all undesirable impurities.

This process is so complete that an examination and chemical analysis of the products are of great interest, as showing how the different constituents of the grain are divided. It is unnecessary, however, to describe the process itself, long accounts of which can be found in the millers' journals of the day and in the Census of 1880, Vol. III, Statistics of Agriculture. It is sufficient merely to know the names of the products and the portion of the grain from which they come.

The first series, consisting of seventy-two specimens, is from the mill of C. A. Pillsbury & Co., Minneapolis, Minn., known as the Pillsbury

"A." This mill, it may be of interest to know, is described in the Census report previously mentioned. It uses the "*hard spring wheat,*" which is grown in the Northwest, and its products, therefore, are typical of this particular variety.

The second partial series is from the mill of Herr & Cissel, in Georgetown, D. C., and the wheat used at the time the specimens were collected was a mixture of Virginia "*Fultz*" and "*Longberry.*" Their products are illustrative, therefore, of the effect of the roller process on Virginia winter wheat.

The third partial series consists of a few specimens resulting from the milling of Ohio winter wheat by Warder & Barnett, of Springfield, Ohio, by the same methods as the others.

The Minnesota samples, being more numerous, will be taken up first.

PARTS OF THE WHEAT GRAIN IN DIFFERENT MILL PRODUCTS.

2001. *Wheat as it enters the mill.*

The whole wheat grain mixed with cockle, oats, and other foreign seed, as it comes from the thrasher.

2002. *Wheat prepared for the rolls.*

The foreign seeds have been removed with the exception of a few grains of cockle and oats. The cockle is therefore to be found in subsequent parts of the process. The hairs have been largely rubbed off, together with portions of the cuticle. Some hairs are, however, still left, and portions of the cuticle remain attached and semi-detached, especially toward the crease. The grain as a whole presents a changed and much cleaner appearance.

2003. *Cockle and screenings.*

Among the foreign seeds there are found principally cockle and a species of polygonum and oats, together with broken pieces of wheat, dirt, chaff, &c.

2004. *Scourings removed by cleaners.*

These consist almost entirely of cuticle and hairs, but portions of epicarp, with the hairs still adherent, and of endocarp are present. Treatment with iodine reveals a small amount of endosperm or starch, and shows the inner part of the outer coats of the grain are the most highly nitrogenous. The contrast between the embryous membrane and endocarp, and the epicarp and cuticle is prominent. The embryous membrane is recognized by its roundish cells; the endocarp by its transverse cells, twice as long as broad, and packed closely and regularly, like cigars, which has given it the name of cigar coat, and the epicarp by its very long and irregular cells arranged longitudinally, the cuticle being of a similar sort.

2005. *First break.*

The grain is split along the crease normally into two halves, but also frequently into fours, or even more irregularly. The glistening, hard, floury endosperm makes its appearance for the first time. Comparatively little flour or dust is made.

2006. *Chop from first break.*

This consists principally of endosperm, but small portions of bran * and germ are present the former, including all the various outer coats.

* Bran is used in this description as denoting and including any part of the coats of the grain.

2007. *Second break.*

In this break the greater part of the endosperm is separated from the bran, and is seen as large well-shapen middlings, together, of course, with some small stuff and dust.

2008. *Chop from second break.*

This is chiefly endosperm, with somewhat less bran than the previous chop. Whole germs and parts are numerous. The endosperm is of all sizes, but the greater portion of large angular fragments. The bran includes portions of all the outer coverings, while dusty matter and starch grains are quite abundant.

2009. *Third break.*

The endosperm is so completely separated in this break that it only remains in scattered patches upon the bran, and the embryous membrane is quite visible.

2010. *Chop from third break.*

The middling or particles of endosperm are much finer, and there is more dust. Small portions of germ are plentiful. The branny particles are similar in nature to those in the last chop but smaller, and there is more dust of a nitrogenous kind.

2011. *Fourth break.*

Only to be distinguished from No. 2009 by the slightly cleaner bran.

2012. *Chop from fourth break.*

Not very different in appearance from 2010, except that it is composed of more finely divided particles.

2013. *Fifth break.*

Still cleaner bran than 2011. It still holds a very appreciable portion of endosperm.

2014. *Chop from fifth break.*

is chop contains a great deal of branny matter, including pieces of epicarp, endocarp, and embryous membrane. The endosperm is very fine and much mixed with germ. Of course, in all these products, portions of the testa and tegmen are present, but they are not easily seen except in careful preparations.

2015. *Sixth break.*

Barely distinguishable from bran.

2016. *Chop from sixth break.*

Very largely made up of small pieces of branny material and germs. The endosperm which is present is very fine.

2017. *Bran.*

This is composed practically of epicarp, endocarp, and embryous membrane, the cells of the latter having been very little disturbed. There is still a little cuticle and endosperm left, but they have mostly disappeared in previous operations.

2018. *Shorts.*

These are made up of all the different parts of the grain in rather a fine condition, some of the branny particles having endosperm still adherent to them.

2019. *Middlings, Uncleaned No.* 1.

These are the largest sized middlings, and consist in themselves of clean, angular fragments of endosperm, but they are mixed with considerable shorts and many whole and broken germs. They are the most impure of the five, and an analysis will show this fact.

2020. *Middlings, Uncleaned No.* 2.

All the particles are finer than in the previous middlings, and less germ and bran is present, which will produce a corresponding change in their chemical composition.

2021. *Middlings, Uncleaned No.* 3.
Still finer than No. 2, and less bran and germ.

2022. *Middlings, Uncleaned No.* 4.
Finer than No. 3, and less bran and germ.

2023. *Middlings, Uncleaned No.* 5.
The finest of all the middlings, with almost no bran and germ. The effect of cleaning will be small.

2024. *Middlings, Cleaned No.* 1.
Many of the lighter particles of bran removed, but there is much remaining, as well as of the germ.

2025. *Middlings, Cleaned No.* 2.
The bran is to a large degree removed in cleaning these middlings, but the germ of course remains.

2026. *Middlings, Cleaned No.* 3.
The bran is almost all gone.

2027. *Middlings, Cleaned No.* 4.
These middlings are practically quite clean and pure endosperm. Only here and there a particle of bran or germ.

2028. *Middlings, Cleaned No.* 5.
Quite clean, and very small in size.

2029. *First middlings, reduction on smooth rolls.*
The germ is flattened, and the endosperm reduced in size.

2030. *Chop from first reduction of middlings.*
This sample appears to be misplaced, as it contains much bran and germ.

2031. *Second middlings, reduction on smooth rolls.*
A sample of this reduction was not furnished.

2032. *Chop from second reduction of middlings.*
This chop contains a few particles of bran and germ.

2033. *Third middlings, reduction on smooth rolls.*
The germ is prominent in its flattened condition.

2034. *Chop from third reduction of middlings.*
The bran and germ have been almost entirely removed.

2035. *Fourth middlings, reduction on smooth rolls.*
Like the middlings themselves, merely reduced in size.

2036. *Chop from fourth reduction of middlings.*
Here and there a small particle of bran seen.

2037. *Fifth middlings, reduction on smooth rolls.*
Resembles of course the fifth middlings.

2038. *Chop from fifth reduction of middlings.*
This is not as white as the chop from the fifth reduction, as it contains bran and germ in small quantities.

2039. *Flour from the first reduction.*
The grains of endosperm are clean and sharp.

2040. *Flour from the second reduction.*
The grains are not as sharp as those from the first reduction.

2041. *Flour from the third reduction.*
Very much like the flour from the second reduction, but perhaps a little lumpier.

2042. *Flour from the fourth reduction.*
More coherent and yellower than previous flours.

2043. *Flour from the fifth reduction.*
There is no specimen of this flour.

2044. *Tailings from middlings purifier No.* 1.
These tailings are coarse. They contain much bran, mixed with germ, and a considerable amount of large middlings.

2045. *Tailings from middlings purifier Nos.* 2, 3, *and* 4.
Much finer than the previous tailings and freer from germ and endosperm.

2046. *Tailings from middlings purifier No.* 6.
Largely composed of fine endosperm, mixed with bran and germ.

2047. *Tailings from the first reduction.*
These are made up of about equal parts of fine endosperm and of bran and germ.

2048. *Tailings from the second reduction.*
These are finer than the first tailings, and contain more germ. There are also present pieces of endosperm, flattened like the germ.

2049. *Tailings from third reduction.*
Still finer, with much-flattened endosperm, and less grain and bran.

2050. *Tailings from fourth reduction.*
Very finely divided and flattened endosperm, with only about 10 per cent. of bran and germ. This should be very evident in the analysis.

2051. *Tailings from fifth reduction.*
Coarser than the fourth tailings, and like the third in quality.

2052. *Repurified middlings.*
Coarse pieces of endosperm, with much bran and germ.

2056. *Bakers' flour.*
Slightly yellow in color. The grains lack distinctness, making the flour lumpy.

2057. *Patent flour.*
A clear white grain.

2058. *Low-grade flour.*
The grain is soft and the flour dark and lumpy. Particles of bran and germ are prominent.

2059. *Break flour.*
Physically like the bakers' grade in appearance, but particles of bran and germ are present, making it of less value.

2060. *Stone flour.*
This flour is white, of a fair grain, with a very little bran.

2062. *Flour from first tailings.*
A very good, free grain, but a little branny.

2063. *Flour from third tailings.*
A free grain, but quite branny and yellow.

2064. *Flour from second tailings.*
This flour resembles that from the first tailings, but contains more bran and is yellower.

2070. *First germ.*
This is made up of the finest particles of germ and contains the largest proportion of middlings and bran.

2071. *Second germ.*
The largest particles of germ, with little bran and endosperm.

2072. *Third germ.*
A medium between the two former.

2074. *Bran-duster flour.*
This is black in color and lumpy. It has little grain and a small portion of bran.

2077. *Stone stock No.* 2.
A good middling, with a little bran and germ.

2078. *Stone stock No.* 3.
This is not as good as No. 2, and holds more bran and germ.

2083. *Tailings from sixth break.*
This is made up of about half barley shaped and flattened pieces of endosperm, the rest being bran, with a little germ.

2084. *Tailings from first centrifugal reel.*

Largely flattened endosperm; the rest germ, with a little bran.

2085. *Tailings from second centrifugal reel.*

These are largely bran and flattened endosperm with a little germ.

2086. *Tail end of the tailings.*

As would be expected, almost entirely bran, with a little adherent endosperm and a small amount of germ. The embryous membrane is still in place; in fact during the whole process there is very little of it removed from the bran, and were it the chief source of gluten there would be very little in any of the products. This, however, is not the case. It contains little or no gluten, being merely a continuation of the germ and having a similar composition.

2087. *Dust from No. 1 middlings.*

This is mostly cuticle epicarp and hairs, with smaller amounts of the more interior parts of the grain.

2088. *Dust from the dust-catcher.*

This is all light, fluffy matter, and is made up of small particles from all parts of the grain.

These observations upon the proportions in which the different portions of the grain enter into the various products enable us to understand and interpret the chemical analyses which follow with greater clearness than could otherwise be done, and it will be seen afterward that with a knowledge of the constituents of the different parts, of bran, the germ and the endosperm, it is comparatively easy to predict almost the exact composition of any of the mill products from the above data.

ANALYSES OF THE PRODUCTS OF ROLLER MILLING.

Serial number.	Names.	Water.	Ash.	Oil.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Phosphoric acid.	Ratio nitrogen to phosphoric acid.	Gluten. Moist.	Gluten. Dry.
	C. A. PILLSBURY & CO., MINNEAPOLIS, MINN.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
2001	Wheat as it enters the mill	9.66	1.91	2.61	69.94	1.70	14.18	2.27	.82	2.77		
2002	Wheat prepared for the rolls	9.07	1.79	2.74	70.37	1.68	14.35	2.30	.82	2.80	32.31	11.88
2003	Cockle and screenings	9.03	2.65	4.32	66.12	4.23	13.65	2.18	.78	2.80		
2004	Scourings removed by cleaners	9.27	3.68	3.73	70.19	1.58	11.55	1.85	.76	2.43		
2005	First break	8.23	1.73	2.68	71.56	1.62	14.18	2.27	.91	2.49	31.92	11.69
2006	Chop from first break	12.52	.88	2.08	70.44	1.13	12.95	2.07	.46	4.50	34.10	12.27
2007	Second break	8.37	2.04	2.47	71.47	1.65	14.00	2.24	.98	2.29	32.78	11.80
2008	Chop from second break	12.78	.57	1.68	71.82	.55	12.60	2.04	.34	5.94	36.88	12.56
2009	Third break	9.92	2.55	5.25	65.10	2.13	15.05	2.41	1.33	1.81	32.09	12.04
2010	Chop from third break	12.70	.78	1.86	71.10	.78	12.78	2.04	.42	4.86	37.19	13.00
2011	Fourth break	8.18	3.30	4.09	66.20	3.00	15.23	2.44	1.44	1.07	27.88	10.54
2012	Chop from fourth break	12.35	1.47	2.87	67.90	1.23	14.18	2.27	.75	5.05	30.52	11.64
2013	Fifth break	7.62	5.16	4.91	61.76	4.80	15.75	2.52	2.58	.98		
2014	Chop from fifth break	11.91	1.99	4.16	64.46	1.73	15.75	2.52	1.01	2.49	27.97	11.82
2015	Sixth break	7.66	5.68	5.34	59.42	5.69	16.28	2.60	2.95	.81		
2016	Chop from sixth break	11.84	3.29	4.92	59.09	3.18	17.68	2.83	1.66	1.70	24.04	10.69
2017	Bran	10.91	5.59	5.03	56.21	5.98	16.28	2.60	2.78	.94		
2018	Shorts	10.94	3.41	4.67	60.28	3.90	16.80	2.69	1.62	1.66		
	Middlings uncleaned:											
2019	No. 1	12.71	1.27	2.73	68.78	1.03	13.48	2.16	.64	3.39	29.68	10.57
2020	No. 2	12.18	1.04	2.16	70.49	.83	13.30	2.13	.54	3.94	32.99	11.49
2021	No. 3	12.27	.70	1.80	71.52	.58	13.13	2.10	.36	5.83	35.52	12.21
2022	No. 4	12.47	.68	1.75	70.69	.58	13.83	2.21	.40	5.52	45.62	15.69
2023	No. 5	12.34	.61	1.75	70.24	.53	14.53	2.32	.33	7.03	43.82	14.86
	Middlings cleaned:											
2024	No. 1	12.67	1.07	2.12	70.16	.85	13.13	2.10	.59	3.56	34.03	11.16
2025	No. 2	9.93	.65	1.90	74.09	.65	12.78	2.04	.33	6.18		
2026	No. 3	12.36	.59	1.70	71.67	.55	13.13	2.10	.24	8.75	44.43	14.99
2027	No. 4	12.51	.52	1.77	71.57	.33	13.30	2.13	.29	7.34	51.93	17.85
2028	No. 5	12.35	.51	1.62	70.74	.43	14.35	2.30	.23	10.00	46.15	14.87
	Middlings, reduction on smooth rolls:											
2029	First middling	12.64	.82	2.56	70.80	.58	12.60	2.02	.46	4.39	34.20	11.57
2030	Chop from first middling	12.74	.72	1.99	71.72	.58	12.25	1.96	.40	4.90	32.16	10.91
2031	Second middling											
2032	Chop from second middling	12.48	.57	1.68	71.24	.38	13.65	2.18	.34	6.41	41.36	13.65
2033	Third middling	12.29	.61	1.86	71.91	.55	12.78	2.04	.34	6.00	36.70	11.81
2034	Chop from third middling	12.73	.79	2.01	71.29	.58	12.60	2.02	.43	4.70	34.58	11.68
2035	Fourth middling	11.43	.56	1.86	73.12	.43	12.60	2.02	.34	5.94	37.00	12.23
2036	Chop from fourth middling	11.72	.50	1.76	72.56	.33	13.13	2.10	.27	7.78	42.06	12.32

2037	Fifth middling	12.21	.65	2.08	71.85	.43	12.78	2.04	.40	5.10	36.25	11.97
2038	Chop from fifth middling	11.47	.56	2.03	72.66	.50	12.78	2.04	.37	5.57	40.84	13.11
	Flour from reduction of middlings:											
2039	First	12.03	.39	1.58	73.70	.25	12.05	1.93	.24	8.04	31.51	10.97
2040	Second	12.42	.44	1.66	72.55	.33	12.60	2.02	.24	8.42	37.04	12.07
2041	Third	11.54	.38	1.36	75.24	.28	11.20	1.79	.19	9.42	32.54	10.99
2042	Fourth	11.58	.40	1.42	72.92	.38	13.30	2.13	.20	10.65	37.90	12.52
2043	Fifth											
	Tailings from middlings purifiers:											
2044	No. 1	12.33	3.30	4.96	60.06	3.25	16.10	2.55	1.61	1.60		
2045	Nos. 2, 3, and 4	11.59	3.09	3.92			14.53	2.32	1.39	1.67	12.28	7.62
2046	No. 6	12.00	.90	2.37	69.10	1.10	14.53	2.32	.49	4.73	39.88	14.37
	Tailings from reduction:											
2047	First	11.78	3.26	5.03	60.32	2.63	16.98	2.72	1.82	1.47	13.04	5.47
2048	Second	10.35	3.38	4.37	59.87	2.08	19.95	3.19	1.68	1.90		
2049	Third	11.72	2.35	4.37	63.27	1.66	16.63	2.66	1.34	1.98		
2050	Fourth	12.09	.88	4.16	68.47	.40	14.00	2.24	.48	4.67	35.73	13.34
2051	Fifth	12.12	2.29	3.85	63.93	1.18	16.63	2.66	1.35	1.97	1.89	.67
2052	Repurified middlings	11.72	2.11	3.67	65.99	1.63	14.88	2.38	1.21	1.08	28.17	10.74
	Finished flour:											
2056	Bakers'	12.18	.62	2.00	69.99	.33	14.88	2.38	.31	7.68	51.21	16.97
2057	Patent	11.48	.39	1.45	73.55	.18	12.95	2.07	.18	11.50	36.14	10.85
2058	Low grade	12.01	1.99	3.86	63.26	.93	17.95	2.74	1.16	2.36	10.01	4.26
2059	Break flour	12.48	.58	1.87	69.44	.23	15.40	2.46	.31	7.94	51.38	15.87
2060	Stone flour	12.04	.49	1.61	72.85	.23	12.78	2.04	.27	7.55	38.21	11.74
	Flour from tailings:											
2062	First	12.55	.62	2.93	70.25	.35	13.30	2.13	.30	7.10	39.13	12.85
2063	Third	12.50	.85	2.79	70.20	.53	13.13	2.10	.45	4.67	37.78	12.68
2065	Second	11.20	.76	2.63	72.28	.48	13.65	2.18	.39	5.59	43.25	13.87
2068	Cockle chop	12.45	2.79	4.34	64.01	3.63	12.78	2.04	.86	2.37		
2069	Cockle bran	7.71	3.46	3.84	65.46	9.03	10.50	1.68	.83	2.02		
2070	First germ	8.69	3.42	9.35	53.28	1.23	24.13	3.86	1.83	2.11		
2071	Second germ	8.75	5.45	15.61	35.19	1.75	33.25	5.32	2.57	1.98		
2072	Third germ	7.68	4.94	13.75	39.25	1.50	32.88	5.26	2.56	2.05		
2074	Bran duster flour	11.78	1.17	2.70	70.20	.50	13.65	2.18	.66	3.30	58.59	13.72
	Stone stock:											
2077	No. 2	12.15	.40	1.64	72.91	.25	13.65	2.18	.19	11.58	47.55	15.32
2078	No. 3	12.01	.55	2.12	71.76	.43	13.13	2.10	.28	7.50	46.39	15.15
	Tailings:											
2083	From sixth break	11.64	2.29	4.06	64.31	1.95	15.75	2.52	1.23	2.05	16.45	6.17
2084	From first centrifugal reel	11.42	2.15	3.44	66.56	1.20	15.23	2.44	.98	2.49	6.58	2.39
2085	From second centrifugal reel	11.07	2.85	4.73	61.82	2.20	17.33	2.79	1.47	1.88		
2086	Tail end of the tailings	11.36	3.87	5.23			15.75	2.52	1.75	1.44	10.74	4.41
2087	Dust from No. 1 middlings	11.03	1.83	2.73	64.86	5.20	14.35	2.30	.55	4.18	25.78	10.31
2088	Dust from dust catcher	11.53	1.17	2.64	69.01	1.65	14.00	2.24	.55	4.07	35.05	13.00
	HERR & CISSEL, GEORGETOWN, D. C.											
2089	Mixed wheat, clean	9.62	1.93	2.29	71.83	1.55	12.78	2.04	.98	2.08	30.00	11.03
2090	First break	8.13	2.03	2.46	72.30	1.60	13.48	2.16	1.05	2.05	29.17	10.42
2091	Second break	9.47	2.00	2.01	71.81	1.58	13.13	2.10	.91	2.30	34.02	11.87
2092	Third break	8.79	2.03	2.37	71.98	1.70	13.13	2.10	1.10	1.90	29.24	10.32

ANALYSES OF THE PRODUCTS OF ROLLER MILLING—CONTINUED.

Serial number.	Names.	Water.	Ash.	Oil.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Phosphoric acid.	Ratio nitrogen to phosphoric acid.	Gluten. Moist.	Gluten. Dry.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
2093	Fourth break	8.91	2.39	2.33	70.97	1.75	13.65	2.18	1.14	1.91	34.08	12.23
2094	Fifth break	7.18	3.46	....	....	....	15.40	2.46	1.35	1.82	26.75	10.09
2095	Sixth break	9.38	4.76	....	....	....	16.10	2.58	2.46	1.04	....	....
2096	First middling	11.96	.49	1.22	75.30	.35	10.68	1.71	.25	6.84	32.99	9.92
2097	Second middling	11.89	.51	1.21	75.56	.33	10.50	1.68	.25	6.72	35.49	10.55
2098	Third middling	10.88	.50	1.19	75.45	.25	11.73	1.88	.24	7.83	42.10	13.32
2099	First middling through smooth rolls	9.87	1.84	2.00	71.98	1.18	13.13	2.10	.87	2.42	28.97	10.59
2100	Patent flour	12.98	.32	.92	75.60	.20	9.98	1.60	.16	10.00	29.55	9.08
2101	Bakers' flour	13.29	.47	1.26	72.45	1.50	11.03	1.76	.28	6.28	35.04	11.30
2102	Low-grade flour	12.59	1.05	2.33	69.10	.75	14.18	2.27	.58	3.91	35.96	12.81
2103	Germ middlings	11.10	2.41	3.74	66.59	1.63	14.53	2.32	1.19	1.94	....	....
2104	Feed middlings or tailings	8.53	3.75	4.96	62.21	4.10	16.45	2.63	1.98	1.32	....	....
2105	Bran middlings	8.24	6.89	5.52	56.77	6.13	16.45	2.63	.98	2.68	....	....
	WARDER & BARNETT, SPRINGFIELD, OHIO.											
1855	Wheat	9.05	2.06	2.46	71.67	2.33	12.43	1.99	1.03	1.93	20.93	10.34
1856	Patent flour	12.32	.34	1.05	75.28	.33	10.68	1.71	.19	9.00	35.52	10.76
1857	Bakers' flour	11.98	.60	1.77	71.52	1.00	13.13	2.10	.33	6.36	38.29	12.30
1858	Low-grade flour	12.36	.69	1.00	75.04	.93	9.98	1.60	.30	5.33	28.37	9.96
1859	Middlings	8.49	4.28	5.94	60.64	3.15	17.50	2.80	1.12	2.50	....	....
1860	Bran	7.74	6.99	4.99	....	....	15.40	2.46	1.04	2.36	....	....
2190	Patent flour, second sample	13.59	.36	1.08	73.94	.35	10.68	1.71	....	....	....	....

INTERPRETATION OF THE ANALYSES.

The wheat as it enters the mill is subjected to a series of operations which removes dirt, foreign seed, the fuzz at the end of the berry, and a certain portion of the outer coats, through the agency of a run of stones and brushes. The result of this operation is to lower the amount of inorganic matter or ash and to increase or decrease the other constituents but slightly, the albuminoids being a few tenths of a per cent. greater in amount. The point from which a convenient start may be made is at the first break.

The chop from the first rolls is very marked in its difference in composition from the original wheat. It of course has less fiber, and also it is seen, less ash, oil, and albuminoids; in fact, it is starchy. It contains more water, owing to the fact that its comminution has allowed it to absorb the moisture from the air, and in general it will be observed that the coarser or more fibrous a specimen is the less water it contains, while the finer material holds more. For example, the percentage of water in several portions of the grain is as follows:

	Per cent.
Original grain	9.66
Ready for the break	8.23
Chop from first break	12.52
Fifth break	7.62
Bran	10 91

The heat caused by the friction of the process, of course, is an active agent; as may be seen on comparing the original grain and that ready for the break. The question of the relation of the various products to humidity is, however, considered in greater detail in another portion of this bulletin.

The starchy chop from the first break is carried off to the various purifying and grading machines, but for the present it will be left, as it is desirable to follow the breaks to the end.

The tailings from the first scalper, consisting of the wheat grain split open along the crease, which serve to feed the second break after the cleaning which they undergo, vary but little from the wheat which goes to the first break. There are slight differences which must be attributed to the diffculty of selecting and preparing for analyses samples of the product of the different breaks, the finer chop having a tendency to sift out from the lighter bran, but they are not great enough to vitiate the conclusions. In the first break so little is done, except to crack open the wheat and clean it for the following rolls, that only a small change should be expected.

The chop from the second break is more from the center of the wheat grain. It contains less ash, fat, and albuminoids than any of the break products, and includes as was shown by our preliminary investigation the greater portion of the endosperm.

The tailings supplying the third break already show, owing to the greater amount of chop produced on the second break, a marked increase in those constituents which are peculiar to the outer portions of the grain, that is to say, there has been a marked increase in ash, fiber, and albuminoids. This increase becomes still more apparent from break to break until the bran alone is left, which contains more ash and fiber than any other product of the wheat. The several chops increase in a like manner, the last or sixth break chop holding more albuminoids than the bran, and even any other of the resulting material. This is probably due to the comminution of the bran in the last break, and consequently, as will be seen, the middlings from this chop are richer in nitrogen than any other, although not the richest in gluten owing to the proportion of bran and germ which they contain.

Having followed the grain through the breaks to the bran, the products of the purification of the chop remain to be studied.

The shorts, or branny particles removed from the chop or from the middlings by aspirators, contain much less fiber and ash than the bran, although they are of similar origin, that is to say, from the outer coats of the grain. The analyses point to their origin from those portions of the coat which contain less ash and fiber.

The middlings are graded into five classes, and in their original uncleaned state they differ chemically in the fact that from No. 1 to No. 5 there is a regular decrease in ash, fiber, and fat, while No. 5 is richer in albuminoids than any other. This would be expected from our preliminary examination which showed a decrease in bran from beginning to end, and that No. 5 was the purest endosperm.

After cleaning the same relations hold good, but owing to the removal of the branny particles there is in all cases a loss of ash constituents and fiber. The effect of cleaning is more apparent in Nos. 1 and 2 where more bran is removed.

The reduction of the middlings on smooth rolls changes the composition but slightly, and the flours which originate from this process are very similar to the middlings from which they were produced. That from the fourth reduction is richer in nitrogen, as would also be the case with the fifth, although want of a specimen prevented an analysis.

The tailings from the middlings purifiers present the usual characteristics of by-products which owe their existence to the outer part of the grain with its high percentages of ash and fibre and, in this case also of nitrogen. It is remarkable, however, that the tailings marked No. 6 contain only one-third as much ash as the others, but this is explained by the fact that they are largely composed of endosperm.

The tailings from the different reductions are nearly alike in composition, with two exceptions: Those from the fourth contain little ash fiber and nitrogen. Like No. 6 of the purifier tailings they consist largely of endosperm. Those from the second reduction contain much germ, and are therefore richer in nitrogen than the rest.

The repurified middlings, as might be expected, contain much more ash, oil, and fiber than the original, and there is also an increase in nitrogen but not in gluten, owing to the large amount of bran they contain.

Analyses of the three grades of flour as furnished to the market follow. From a cursory glance it might be said that the low-grade flour was the best, as it contains the most albuminoids, but its weakness is discovered in the fact that it has only 4 per cent. of gluten. The bakers' flour contains more ash, oil, fiber, albuminoids, and gluten than the patent, but owing to the increased amount of the first three constituents mentioned, it is proportionately lacking in whiteness and lightness. The two flours each have their advantageous points.

Several other grades of flour, break flour, stone flour, and flours from the first, second, and third tailings, are all very similar, and, as far as chemical analyses is concerned, good. The preliminary examination has, however, shown certain defects in each. The break flour is richer in albuminoids and gluten than any other, and if were pure and its physical condition were good it would be of value.

The roller process is distinguished for the completeness with which it removes the germ of the grain during the manufacture of flour by flattening and sifting it out. This furnishes the three by-products which are known as first, second, and third germ. They consist of the germ of the wheat mixed with varying proportions of branny and starchy matter, the second being the purest. They all contain much ash, oil, and nitrogen, and if allowed to be ground with the flour blacken it by the presence of the oil and render it very liable to fermentation, owing to the peculiar nitrogenous bodies which it carries. A more complete analysis appears in another place.

The flour from the bran-dusters is much like that from the tailings, and like the stone stock, from a chemical point of view. This merely shows that chemical evidence should not alone be taken into consideration, for the bran-duster flour is a dirty, lumpy by-product, while the stone stocks are valuable middlings. Analyses of various tailings are next in the series, and need no comment. Those of the dust from middlings and dust-catchers are rather surprising, in that they both contain much gluten and the first one much fiber, but this is due to their containing both bran and endosperm.

To follow the gluten through the process it is necessary to go back to the breaks. The amount in the various chops does not vary greatly. There is an apparent anomaly, however, in the fifth and sixth breaks, where no gluten was found in the feed but much in the chop. This is owing to the fact that the feed has become at this point in the process so branny that by the usual method of washing to obtain the gluten it does not allow of its uniting in a coherent mass and separating from the bran.

Among the middlings, both uncleaned and cleaned, the fourth is the

richest in gluten, and the result of the process of cleaning is to increase the amount, although slightly diminishing the nitrogen, which is due to the removal of the branny matter, which, though rich in nitrogen, is poor in gluten.

In the products of the reduction on smooth rolls, the chops from the higher middlings are the richest, and if the analyses of the flours were complete, No. 4 would probably contain more than the lower numbers.

The tailings are, as have been already said, remarkable, not so much that No. 1 has no gluten, but that Nos. 2, 3, 4, have 7.62 per cent., and No. 6 as much as 14.37 per cent. The regular increase shows that the highest numbers must contain a large portion of endosperm.

That this is the case the microscopic examination of the different tailings has shown. No. 1 is found to consist almost entirely of the outer coatings of the grain; Nos. 2, 3, and 4 of the same mixed with a large proportion of endosperm, which is attached thereto, while in No. 6 it is difficult to discover any large amount of anything but flouring material, and the small percentage of ash shows also that it cannot contain much bran.

In a like manner No. 4 tailings from the reductions has 13.34 per cent. of gluten, which is owing to the large proportion of endosperm which it contains, and in this case, too, the fact of the presence of so much of the interior of the berry is presaged by the low percentage of ash. The remaining tailings of this class have little or no gluten, with the exception of No. 1, as they contain very little endosperm.

In connection with the remaining specimens the gluten has been already mentioned, and the results as a whole warrant the conclusion that less of it is wasted in the by-products than would be imagined. For a complete discussion of this point data, which are not at hand in regard to the per cent. of each material produced, are necessary.

The products from Virginia wheat, similar to those which have just been described, present the same but not as wide variations in the breaks and in the flours; the low grade, instead of containing less gluten, has more than the bakers' or patent. This may be due to the greater softness of the wheat, in consequence of which it is less suited to the process, a fact which is confirmed to a certain degree by the specimens of flour from Ohio wheat, among which the low grade, although not exceeding the other brands in the amount of gluten, approaches very nearly to them, and it is therefore only reasonable to conclude that the spring wheats are particularly suited for roller milling.

PHOSPHORIC ACID IN THE ASH.

The ash of several samples of wheat and flour have been analyzed. The specimens were selected to represent variations in locality, in hardness, and color, and between winter and spring wheats.

1284. *Champion Amber.*

Pennsylvania; crop of 1879; red wheat.

1288. *Gold Dust.*

Pennsylvania; crop of 1879; yellow wheat.

2001. *No. 1, Hard spring.*

Minnesota; crop of 1883; hard red spring, from C. A. Pillsbury & Co.'s mill.

2111. *No. 1, Hard spring.*

Dakota; crop of 1883.

2114. *Flour from No. 1.*

Hard spring; Pillsbury "A," best.

Ash analyses of wheats and flours.

	1284.	1288.	2001.	2111.	2114.
	Pennsylvania red.	Pennsylvania yellow.	Minnesota.	Dakota.	Pillsbury "A."
Per cent. of ash	1.63	1.47	1.83	1.88	.409
Insoluble	.067	.025	.049	.027	.004
Phosphoric acid	.796	.729	.828	.888	.203
Potash	.480	.398	.533	.575	.129
Magnesia	.216	.237	.270	.302	.037
Lime	.058	.034	.088	.063	.024
Soda	.015	.046	Trace.	022	.012
Sulphuric acid	Trace.	Trace.	.020	Trace.	....
Chlorine	Trace.	Trace.	.035	Trace.	....
Iron	Trace.	Trace.	Trace.	Trace.	....
Manganese	....	....	.005	....	....
Per cent. composition of ash.					
Insoluble	4.11	1.70	2.57	1.44	.98
P_2O_5	48.77	49.63	45.35	47.31	49.63
K_2O	29.41	27.09	29.19	30.63	31.54
MgO	13.24	16.13	14.79	16.09	9.05
CaO	3.55	2.32	4.81	3.36	5.87
Na_2O	.92	3.13	Trace.	1.17	2.93
SO_3	Trace.	Trace.	1.10	Trace.	....
Cl	Trace.	Trace.	1.92	Trace.	....
Fe_2O_3	Trace.	Trace.	Trace.	Trace.	....
MnO	....	....	.27	....	....

The percentage composition of the several ashes include extremely slight variations. The ash of soft wheat contains a little less potash and lime and more magnesia than the ash of the red wheat grown on the same soil, but the variations are too slight for consideration and the composition is quite like the ash of foreign wheat for which Wolff gives the following average:

	Winter wheat.	Spring wheat.
	Per cent.	*Per cent.*
Insoluble	2.11	1.64
P_2O_5	46.98	48.63
K_2O	31.16	29.99
MgO	11.97	12.09
CaO	3.34	2.93
Na_2O	2.25	1.93
SO_3	.37	1.52
Cl	.22	.48
Fe_2O_3	1.31	.51
Undetermined	.29	.28
Total	100.00	100.00
Total ash	1.97	2.14

The conclusions which Von Bibra long ago expressed concerning the wheats which he had examined seem to hold good for this country as well as for Germany. It is only exceptionally that the inorganic constituents of a wheat overstep certain limits, while within them it is liable to frequent variations even on the same field and under otherwise similar conditions.

The analysis of the ash of the flour from Minnesota shows a marked decrease in the percentage of magnesia which it contains, made up principally by an increased amount of lime. Dempwolff's analyses of Hungarian flours gave a similar result. The phosphoric acid, too, is higher, showing that in the interior of the grain, and apparently also in the softer wheats, there is more of this constituent present.

A discussion of the ash constituents of the grain in its different portions will be found in Liebig's Annalen der Chemie, Band CXLIX, S. 345, by Dempwolff. It is quoted by Horsford, in his report on bread at Vienna in 1873, and attention is called to the decrease in percentage of magnesium in the ash of the center of the grain, accompanied by an increase in calcium and potassium, and the fact that phosphoric acid forms about 50 per cent. of the ash. Determinations of the latter constituent in the milling products from Minnesota show that with the hard spring wheats the relative percentage in the ash is higher toward the interior of the grain.*

In the flours as graded for the market the same fact is observed.

RELATION OF NITROGEN TO PHOSPHORIC ACID.

After the consideration of the variations in the ash, it is of interest to observe the relation between the phosphoric acid which it contains and the nitrogen. A column in the table of analyses gives this ratio, expressed as the factor by which the phosphoric acid must be multiplied to equal the nitrogen.

Starting with a ratio of 2.8 in the whole grain, with every purification of the product the figure rises until it reaches the highest grade middlings and patent-flour; that is to say, as we approach the more perfect products there is a greater loss of phosphates than of nitrogen. The highest ratios are found in the patent-flours and in the chop and middlings, which lead directly to this product. In the flours from the reduction of the different grades of middlings the change in the ratio is gradual and corresponds closely to the inverse change in the amount of phosphates in the ash. A high ratio denotes, therefore, a deficiency in phosphates, and this is the chief fault with the high grade flours.

THE GERMS.

One of the characteristic features of the roller-milling process, as has been mentioned, is the removal of the germ of the grain, thus prevent-

* See also Lowe's and Gilbert's paper on the Ash Constituents of Wheat, *Journ. Chem. Soc. XLV*, 305, *Aug.*, 1884, and Appendix of this report.

ing its injuring the quality of the flour. Among the by-products of the Pillsbury mill, are included three separations of germs known as first, second, and third. They are all rich in oil and albuminoids, which together form one-half of the substance. The second germ seems to be freer from contamination and was selected for a more detailed examination.

The following determinations were made:

Analysis of germ.

	Per cent.	Per cent.
Water	....	8.75
Ash	....	5.45
Oil	....	15.61
Soluble in 80 per cent. alcohol	26.45	....
Insoluble in water	....	1.98
Soluble in water	25.47	....
Sugar or dextrine	....	18.85
Non-reducing substance	....	2.94
Albuminoids	....	3.65
Soluble in water	4.44	....
Dextrine	....	1.44
Albuminoids	....	3.00
Starch, &c., undetermined	....	9.95
Fiber	....	1.75
Insoluble albuminoids	....	26.60
		100.00

The interest of the analysis centers in the presence of so much sugar and soluble albuminoids. The sugar has been calculated to percentage as if it were dextrose. It does not reduce Fehling's solution until inverted by acids. It is dextro-rotatory, by inversion becoming less so, but not laevo-rotatory. It is uncertain whether it is formed from starch which may be present through the action of some ferment in the germ; but it seems probable, especially since so much soluble nitrogen is present pointing to diastatic action, and it may be classed somewhere between dextrine and maltose. In fact it has been found that the water extract if left in contact with the residue of the germ would soon be the cause of a peculiar fermentation. This shows the bad effect the presence of this soluble albuminoid would have in flour, causing a fermentation or putrefaction which would injure and discolor it. The oil in the germ is also an additional source of trouble, in that it is readily oxidized under certain circumstances and tends to blacken the flour.

THE RELATIONS OF THE WHEAT GRAIN AND ITS PRODUCTS TO THE HUMIDITY OF THE AIR.

In the report of W. H. Brewer on the cereals, in Vol. III of the Census for 1880, he gives the results of certain experiments by Hilgard, of California, showing the changes in weight of wheat, when exposed to alternations of dry and moist air; California wheat, being particularly dry as it comes from the hot valleys where it grows, absorbs a large amount of moisture in the seaports, or during transportation by sea. Brewer

extended these experiments to all the cereals, and weighing them at intervals found that under the conditions which he employed they without exception lost about the same amount from summer to winter that they would gain from winter to summer, and that when artificially dried and again exposed to the air, a few minutes would suffice for the absorption of several per cent. of moisture.

The importance commercially of this capacity for absorbing or losing moisture is of course apparent, and experiments were undertaken before the appearance of Brewer's report for a more thorough investigation of the subject, in reference especially to mill products.

The materials were exposed in the balance-room of the laboratory of the department properly protected by a screen from exterior influences other than atmospheric. The condition of the atmosphere was noted by means of a psychrometer at the time of weighing.

The first series consisted of a number of flours from Minnesota, all milled by the roller process from hard spring wheats. Three of the five contained nearly 8 per cent. of water originally, one a little over 9, and one over 13. The first day of exposure was comparatively dry for the climate of Washington, but evidently moist as compared to the localities from which all the flours but one had come, because there was a large gain in the part of three, a small gain by the Pillsbury "A," and a loss by the only one holding originally a large amount of moisture; in fact, the result was an approximation to equalization of moisture in all, as would be expected. If we add the gains and subtract the losses the figures, though not representing actual percentages, would appear for moisture as follows, on the second day:

Number.	Original moisture	Gain or loss.	Second day.
2114	9.48	+.65	10.13
2115	7.80	+2.15	9.95
2116	7.85	+2.30	10.15
2117	7.97	+2.15	10.12
2120	13.69	−3.28	10.41

The first day's exposure was sufficient, therefore, to equalize the moisture in all the flours, and following them through the succeeding weeks they all appear to be susceptible to the changes in condition of moisture in about the same degree.

A specimen of the whole grain exposed beside the flour proved itself not as susceptible as the finer material, but nevertheless responded to a certain degree to the daily changes in humidity. A tabulation of the results follows:

EXPERIMENTS ON THE HYGROSCOPIC RELATIONS OF FLOURS.

	Serial number.	Original per cent. of moisture.	March 8.		March 10.		March 11, 8 a. m.		March 11, 3 p. m.		March 12.		March 13.		March 14.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb, °Fahr	....	....	73°	....	69°	....	62°	....	70°	....	68°	....	68°	....	69°5	....
Wet bulb, °Fahr	....	....	61°	....	55°	....	54°	....	61°5	....	60°	....	54°	....	(?)	....
Relative humidity, per cent	....	....	46.4	....	35.0	....	56.1	....	59·0	....	60.1	....	34.0	....	....	....
FLOURS.																
Pillsbury "A," best	2114	9.48	+ .65	100.65	−1.12	99.53	+1.30	100.83	+ .90	101.73	+ .95	102.68	−2.80	99.88	+1.20	101.08
Patent Red River	2115	7.80	+2.15	102.15	− .73	101.42	+1.10	102.52	+1.00	103.53	+1.05	104.57	−2.60	101.97	+1.10	103.07
Patent Frazee, Minnesota	2116	7.85	+2.30	102.30	− .60	101.70	+1.10	102.80	+1.00	103.80	+1.15	104.95	−2.70	102.25	+1.00	103.25
Patent Pembina	2117	7.97	+2.15	102.15	− .60	101.55	+1.20	102.75	+ .85	103.60	+1.20	104.80	−2.75	102.05	+1.10	103.15
Patent Minnesota	2120	13.69	−3.28	96.72	−1.37	95.35	+1.20	96.55	+ .80	99.35	+ .85	98.20	−2.70	95.50	+1.10	96.60
WHOLE WHEAT.																
Lamoure County, Dakota, spring	2111	9.57	....	....	....	....	+ .26	100.26	− .09	100.17	+1.25	101.42	− .92	100.50	− .08	100.42

NOTE.—In this table the figures in the second column of each date represent the weight which 100 lbs. of the original flour would have assumed under the conditions named.

EXPERIMENTS ON THE HYGROSCOPIC RELATIONS OF FLOURS—CONTINUED.

	Serial number.	Original per cent. of moisture.	March 15.		March 17.		March 18.		March 19.		March 20.		March 21.		March 22.		March 24.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb, °Fahr.	......	......	70°	....	63°	....	67°	....	68°	....	71°5	....	69°	....	68°	....	67°5	....
Wet bulb, °Fahr.	......	......	50°	....	32°	....	59°	....	60°	....	62°	....	59°	....	58°	....	61°	....
Relative humidity, per cent.	......	......	48.2	....	42.2	....	59.5	....	60.1	....	55.6	....	51.8	....	51.1	....	66.9	....
FLOURS.																		
Pillsbury "A," best	2114	9.48	+ .45	101.53	−1.15	100.38	+1.50	101.88	+ .15	102.03	+ .45	102.48	−1.05	101.43	+ .25	101.68	+1.20	102.88
Patent Red River	2115	7.80	+ .55	103.62	−1.35	102.27	+1.35	103.82	+ .15	103.97	+ .65	104.62	−1.20	103.42	+ .30	103.72	+1.15	104.87
Patent Frazce, Minnesota	2116	7.85	+ .50	103.75	−1.10	102.65	+1.50	104.15	+ .10	104.25	+ .60	104.85	−1.20	103.65	+ .30	103.95	+1.25	105.20
Patent Pembina	2117	7.97	+1.35	104.50	−1.00	103.50	+1.40	104.90	+ .17	105.07	+ .50	105.57	−1.12	104.45	+ .30	104.75	+1.20	105.95
Patent Minnesota	2120	13.69	+1.30	97.90	−1.00	96.90	+1.40	98.30	+ .13	98 43	+ .42	98.85	−1.00	97.85	+ .30	98.15	+1.20	99.35
WHOLE WHEAT.																		
Lamoure County, Dakota, spring	2111	9.57	+ .26	100.68	− .36	100.32	+ .75	101.07	+ .08	101.15	+ .34	101.49	− .30	101.19	− .08	101.11	+ .84	101.95

NOTE.—In this table the figures in the second column of each date represent the weight which 100 lbs. of the original flour would have assumed under the conditions named.

Flours of the same quality being so much alike in their faculty of absorbing moisture, the experiment was made of exposing different grades with the object of learning whether they would be independent in their action. The results in the table show that the starchy patent grade has a rather greater affinity for water than the others, and that the bakers' grade which is the most glutinous has the least.

EXPERIMENTS ON THE HYGROSCOPIC RELATION OF GRADES OF FLOUR.

Name.	Serial number.	Original per cent. of moisture.	March 15.		March 17, 10 a. m.		March 18, 10 a. m.		March 19, 10 a. m.		March 20, 10 a. m.		March 21, 10 a. m.		March 22, 10 a. m.		March 24, 10 a. m.		March 27, 10 a. m.		March 27, 1 p. m.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb, °Fahr	......	......	70°	......	63°	......	67°	......	68°	......	71.5	......	......	......	......	......	......	......	......	......	......	......
Wet bulb, °Fahr	......	......	59°	......	52°	......	59°	......	60°	......	62°	......	......	......	......	......	......	......	......	......	......	......
Relative humidity per cent.	......	......	48.2	......	42.2	......	59.5	......	60.1	......	55.6	......	Moist.	......	Moist	......	Moist.	......	Moist	......	Dry..	......
GRADES OF FLOUR.																						
Bakers'	2056	12.18	−.75	99.25	−1.60	97.65	+1.25	98.90	+.38	99.28	+.32	99.60	+6.25	105.85	+.35	106.20	+1.12	107.32	+.40	107.72	−7.35	100.37
Patent	2057	11.48	+.95	100.95	−1.05	99.90	+1.40	101.30	+.45	101.75	+.40	102.15	+5.55	107.70	+.50	108.20	+1.30	109 50	+.30	109.80	−6.18	103.62
Low grade	2058	12.01	−.62	99.38	−1.37	98.01	+1.40	99.41	+.35	99.76	+.30	100.06	+7.10	107.16	+.40	107.56	+1.70	109.26	+.40	109.66	−7.80	101.86

The approximate agreement between the different grades of flour under ordinary conditions being apparent, they were submitted to an atmosphere nearly saturated with moisture; that is to say, they were placed under a bell with a dish of water. They all gained from 7 to 9 per cent. over their air dry weight, but the low grade and patent flour possessed the largest capacity for moisture, the bakers' holding about 2 per cent. less. On removal to dry air this gain was lost in a very few hours, the bakers' losing a proportionately larger amount than the others. Whether it is owing to a larger percentage in gluten in this flour that it gains less and loses more water than others is questionable.

A Minnesota patent exposed in a small desiccator to air saturated with moisture absorbed more than 26 per cent. of its original weight in sixty-four hours, and in one hundred and eight hours, or four days, more than 29 per cent; but at that time a film of mold covered the flour. The determinations at intervals showed the gain to be—

	Grams.
Weight of flour taken	1.0000
Weight after 35 minutes	1.0285
Weight after 18 hours	1.0930
Weight after 22 hours	1.2005
Weight after 42 hours	1.2405
Weight after 64 hours	1.2670
Weight after 92 hours	1.2915

The flours are plainly more susceptible to moisture than the grain owing to their greater comminution. It was found in California that the latter after being artifically dried would absorb 25 per cent. of moisture. Here a flour, although not dried, has absorbed over 29 per cent. of its original weight.

To decide what parts of the grain were able to absorb and retain the most moisture, how far the degree of comminution affected the result, several of the most prominent products of the roller process were treated in the same way as the previous specimens.

EXPERIMENTS ON THE HYDROSCOPIC RELATIONS OF MILL PRODUCTS.

	Serial number.	Original per cent. of moisture.	April 1.		April 2.		April 3.		April 5.		April 7.		April 10.		April 12.		April 14.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb °Fahr	......	68°	68°	....	70.5	....	72°	....	69°	....	70	....	70°	....	69°	....	68°	....
Wet bulb °Fahr	......	55°	56°	....	60°	....	58°	....	55°	....	57	....	58°	....	56.5	....	60°	....
Relative humidity (per cent.)	......	38.1	42.4	....	50.7	....	37.8	....	35.0	....	40.0	....	44.1	....	41.1	....	60.1	....
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	−.30	99.70	+.50	100.20	−1.00	99.20	−.16	99.04	+.57	99.61	−.05	99.56	−1.05	98.51	+2.83	101.34
Bran (80 mesh)	2017	10.91	+.47	100.47	+2.20	102.67	−.90	101.77	−.15	101.62	+.57	102.19	+.02	102.21	−.11	102.10	+2.17	104.27
Shorts (80 mesh)	2078	10.94	+.03	100.03	+1.05	101.08	−.95	100.13	−.15	99.98	+.62	100.60	−.03	100.57	−.11	100.46	+2.00	102.46
Third germ (80 mesh)	2072	7.68	−.28	99.72	+.90	100.62	−1.30	99.32	−.10	99.22	+.55	99.77	+.08	99.85	−.16	99.69	+2.46	102.15
Patent flour	2114	9.48	−.05	99.95	+1.15	101.10	−1.20	99.90	−.15	99.75	+.63	100.38	+1.17	101.55	−.17	101.38	+1.94	103.32
Bran (coarse)	2017	10.91	−.60	99.40	+.45	99.85	−1.25	98.60	−.15	98.45	+.42	98.87	+.18	99.05	−.15	98.90	+1.78	100.68
Fifth middlings	2028	12.18	−.85	99.15	+.30	99.45	−1.30	98.15	−.20	97.95	+.38	98.33	+.17	98.50	+.17	98.33	+1.79	100.12

EXPERIMENTS ON THE HYGROSCOPIC RELATIONS OF MILL PRODUCTS—CONTINUED.

	Serial number.	Original per cent. of moisture.	May 7.		May 12.		May 13.		May 14.		May 15.		May 19.		May 21.		May 23.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb °Fahr.	......	68°	70.5	......	70°	......	70°	......	72°	......	72°	......	74°	......	75°	......	77.5	......
Wet bulb °Fahr.	......	55°	62.5	......	56°	......	59.5	......	59.5	......	58°	......	65°	......	64.5	......	71°	......
Relative humidity (per cent.)	......	38.1	61.5	......	35.9	......	50.3	......	43.7	......	3.78	......	59.3	......	53.7	......	71.2	......
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	+1.65	102.99	−2.45	100.54	+.65	101.19	+.01	101.20	−.44	100.76	+2.06	102.82	−.73	102.09	+1.05	101.05
Bran (80 mesh)	2017	10.91	+1.60	105.87	−2.47	103.40	+.72	104.12	−.01	104.11	−.50	103.61	+2.26	105.87	−.95	104.92	+1.40	101.40
Shorts (80 mesh)	2078	10.94	+1.37	103.83	−2.45	101.38	+.70	102.08	+.15	102.23	−.60	101.63	+2.25	103.88	−.93	102.95	+1.33	101.33
Third germ (80 mesh)	2072	7.68	+1.82	102.97	−2.90	100.07	+.95	101.02	+.11	101.13	−.69	100.44	+3.33	103.77	−1.65	102.12	+2.20	102.20
Patent flour	2114	9.48	+1.31	104.63	−2.50	102.13	+.72	102.85	+.02	102.87	−.62	102.25	+2.14	104.39	−.73	103.66	+1.01	101.01
Bran (coarse)	2017	10.91	+1.02	101.70	−2.50	99.20	+.77	99.97	+.07	100.04	−.61	99.43	+2.17	101.60	−.75	100.85	+1.35	101.35
Fifth middlings	2028	12.18	+1.08	101.20	−2.43	98.77	+.68	99.45	+.20	99.65	−.80	98.85	+2.06	100.91	−.60	100.31	+.94	100.94

EXPERIMENTS ON THE HYGROSCOPIC RELATIONS OF MILL PRODUCTS—CONTINUED.

	Serial number.	Original per cent. of moisture.	May 24.		May 26.		May 29.		June 5.		June 7.		June 10.		June 12.		June 27.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb °Fahr	......	68°	78.5	....	74.5	....	68°	....	80°	....	75°	....	77.5	....	75°	....	73°	....
Wet bulb °Fahr	......	55°	73.	....	67.5	....	54.5	....	65°	....	69°	....	71.5	....	71°	....	61°	....
Relative humidity (per cent.)	......	38.1	75.7	....	67.9	....	36.0	....	40.7	....	72.4	....	73.3	....	81.2	....	46.4	....
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	+1.47	102.52	−1.12	101.40	−3.40	98.00	+1.52	99.52	+2.68	102.12	+.90	103.02	+.45	103.47	−3.77	99.70
Bran (80 mesh)	2017	10.91	+2.00	103.40	−1.80	101.60	−3.48	98.12	+1.48	99.60	+3.30	102.90	+1.28	104.18	+.37	104.55	−4.95	99.60
Shorts (80 mesh)	2078	10.94	+1.77	103.10	−1.49	101.63	−3.61	98.02	+1.41	99.43	+3.32	102.75	+1.18	103.93	+.40	104.33	−4.88	99.45
Third germ (80 mesh)	2072	7.68	+2.90	105.10	−2.95	102.15	−4.56	99.59	+1.47	99.06	+5.19	104.25	+1.65	105.90	+.25	106.15	−7.20	98.95
Patent flour	2114	9.48	+1.22	102.23	−0.90	101.33	−3.40	97.93	+1.60	99.53	+2.30	101.83	+.75	102.58	+.33	102.91	−3.28	99.63
Bran (coarse)	2017	10.91	+1.76	103.11	−1.56	101.61	−3.47	98.14	+1.45	99.59	+3.10	102.69	+1.17	103.86	+.35	104.21	−4.73	99.48
Fifth middlings	2028	12.18	+1.20	102.14	−.90	101.24	−3.22	98.02	+1.52	99.52	+2.30	101.84	+.75	102.59	+.30	102.89	−3.35	99.54

The coarser products absorbed less moisture than the finer, at least where there was a marked change, and among the fine material there was less difference than might be expected. The germ after more than two months' exposure seemed to have accumulated more water than any other, but a rather dry atmosphere, with the thermometer at 73° F. on the 27th of June, brought the whole series below their original degree of moisture. A fresh portion of the germ exposed for a few days for comparison with that which had been weighed out longer, rapidly reached a point even in excess of the latter, it being fresher and not caked so much together. The gains and losses were as follows:

No. 2072.

May 24, 1.30 p. m	102.88
May 24, 2.30 p. m	103.18
May 26, 10 a. m	103.93
May 28, 10 a. m	104.83
May 29, 10 a. m	99.28
June 5, 10 a. m	100.83
June 9, 10 a. m	106.13
June 10, 10 a. m	107.69

and then left in the balance case with a dish of sulphuric acid for forty-eight hours:

June 12	104.05

and over chloride of calcium in a desiccator forty-eight hours:

June 14	96.38

or nearly dry.

The results are instructive, and show how susceptible all portions of the wheat grain, in whatever state of comminution, are to hygroscopic conditions, and it will be noticed, as was found by Brewer, that in summer the amount of moisture held by grain is larger than in winter.

FLOURS.

The analyses of flours given in a previous bulletin having proved unsatisfactory to the millers of the Northwest, they furnished the Department with a series of selected samples of the best Minnesota and Dakota "patents." These, together with an Ohio, and a District of Columbia "patent flour," obtained directly from the millers, have been analyzed.

AMERICAN FLOURS OF 1883.

	1856.	2100.	2057.	2114.	2115.	2116.	2117.	2118.	2119.	2121.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Water	12.32	12.98	11.48	9.48	7.80	7.85	7.97	7.64	8.11	11.33
Ash	.34	.32	.39	.39	.42	.42	.45	.42	.52	.91
P_2O_5	.18	.16	.21	.26	.27	.23	.23	.26	.32	.48
Nitrogen	1.71	1.60	2.07	1.99	2.02	1.99	1.88	2.13	2.16	2.18
Albuminoids	10.68	9.98	12.95	12.43	12.60	12.43	11.73	13.30	13.48	13.65
Moist gluten	35.52	29.55	....	36.14	41.05	40.82	35.20	36.60	44.85	36.73
Dry gluten	10.76	9.08	....	10.85	11.74	11.81	10.58	11.11	12.59	12.03

1856 Patent Flour, Warder & Barnett, Springfield, Ohio.
2100 Patent Flour, Herr & Cissel, Georgetown, D. C.
2057 Patent Flour, C. L. Pillsbury, Minneapolis, Minn.
2114 Patent Flour, Pillsbury "A," best, Minneapolis, Minn.
2115 Patent Flour, Red River Roller Mills, Fergus Falls, Minn.
2116 Patent Flour, R. L. Frazee, Frazee City, Minn.
2117 Snow Cloud, Pembina Mill Co., Pembina, Dak.
2118 Fargo's Best, Fargo Roller Mills, Fargo, Dak.
2119 No. 1 Straight, Fargo Roller Mills, Fargo, Dak.
2121 Patent Flour, George Davis, Ottawa, Minn.

The Eastern flour is poorer in nitrogen and gluten than any of the others. In fact the flours follow closely the composition of the wheat, which has been examined from the same parts of the country. Dakota makes a flour richer than any other in gluten in the same way that it produces a wheat of that description. The sample from Pembina, like the wheat from that locality, is lower than any other spring wheat flour. The average of these "Northwestern spring wheat flours," is high and in comparison with the rest of the country they are the richest which have been analyzed. They compare favorably with Hungarian roll flour, which they closely resemble.

AVERAGE COMPOSITION OF FLOURS.

	Forty-nine flours, U. S. Census.	Eight Eastern flours.	Minnesota and Dakota flours.
	Per cent.	*Per cent.*	*Per cent.*
Water	11.56	12.49	8.96
Ash	.59	.55	.44
Undetermined albuminoids	11.90	10.41	12.82

Another peculiarity of the spring wheat flours is their dryness. It will be seen in the averages that they contain several per cent. less moisture than the Eastern specimens. From the results of the experiments on the relations of such material to atmospheric conditions it is plain that they would gain weight on transportation east or to the coast, and other things being equal, a barrel of dry Western flour would make more bread than a barrel of Eastern. This is certainly an important factor in the consideration of the value of flours. In specimens Nos. 2057 and 2121 the absorption had, to a large extent, taken place, while the others, being tightly boxed, were received without any absorption.

How readily this would have taken place had an opportunity occurred, will be seen in the analyses of the flours used for baking.

In the light of the preceding analyses there seems to be no reason to doubt but that the introduction of the roller-milling process and the growth of the hard wheats of the Northwest has furnished the country with a finer flour than it has before possessed, and one which should make a bread comparing favorably with Hungarian manufacture. In fact in the baking experiments the bread made from these flours excelled all others in quality.

The flours which have just been mentioned as used for experimental baking purposes have been so far examined as to determine the percentages of water, nitrogen, and albuminoids, and moist and dry gluten. The results are here collected.

ANALYSES OF FLOURS USED IN BAKING.

Variety.	Serial number.	Water.	Nitrogen.	Albumen.	Gluten.	
					Moist.	Dry.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Maryland patent	2593	11.55	1.65	10.33	33.32	9.60
Maryland straight	2800	11.08	1.75	10.94	32.49	10.28
Maryland low-grade	2808	12.78	1.84	11.50	30.15	11.13
District Columbia patent	2821	12.98	1.46	9.10	31.58	9.09
District Columbia straight	2820	12.38	1.53	9.56	33.40	9.76
Virginia straight	2591	12.16	1.93	12.08	36.07	11.41
Virginia low-grade	2807	11.77	2.02	12.60	36.81	11.60
Virginia patent	2805	12.10	1.73	10.81	37.89	11.08
Ohio patent	2190	12.85	1.70	10.62	29.63	10.47
Indiana patent	2822	12.33	1.59	9.94	33.60	10.03
Illinois patent	2594	12.00	1.93	12.08	37.36	11.56
Wisconsin straight	2801	12.37	1.60	9.98	28.39	9.56
Wisconsin patent	2806	13.25	1.85	11.55	34.45	10.65
Minnesota patent	2592	12.82	1.90	11.90	39.18	11.98
Minnesota low-grade	2599	12.05	2.51	15.64	34.22	14.06
Minnesota bakers'	2803	11.77	1.95	12.19	36.71	11.71
Missouri patent	2804	12.04	1.67	10.44	32.24	9.23
Oregon new process	2824	14.03	1.15	7.18	20.84	6.75

They are remarkably uniform in albuminoids and gluten, and also in moisture, showing that they had, with the exception of the Oregon flour, been subjected to very similar hygroscopic conditions. The flours from Minnesota have, without doubt, gained moisture since they were originally milled, if it is possible to judge from previous analyses of samples sent directly from the mills. For this reason, in our bread experiments with this collection of flours, less variation in yield was found than if they had been used directly from the mill with wider variations in their per cent. of moisture.

Among them all two present peculiarities worthy of notice. The Oregon new-process flour contains 7.18 per cent. of albuminoids, the smallest amount yet found in the course of analysis. In this respect it corresponds to Oregon wheat, and confirms the remarks thereon on a previous page. On the other hand the Minnesota low grade contains

more albuminoids and gluten than any heretofore examined. This would not only be remarkable for any flour, but is still more so for one of low grade. How it was graded is unknown. It makes a very dark bread.

BAKING EXPERIMENTS WITH FLOURS FROM VARIOUS SOURCES.

The experiments of the McDougall Brothers in London, in the autumn of 1882, upon the baking qualities of flour made from wheats in the English market from different parts of the world, have had a wide circulation. The statistician of this Department in his report upon the condition of the crops for December, 1883, mentions and quotes them as follows:

EXPERIMENTS IN BREAD-MAKING.

In the autumn of 1882 the secretary of state of India arranged with McDougall Brothers, millers and bakers, London, to conduct a series of experiments with wheats from India in comparison with average samples of wheat from the principal countries producing this grain. Of the conditions required by the secretary they say:

"1. That we should take a given quantity of each of these four representative Indian wheats, viz., Indian fine soft white, Indian superior soft red, Indian average hard white, Indian average hard red, and manufacture them into flour by the ordinary process of grinding under millstones. Also that we should take similar quantities of the same wheats and manufacture them into flour by means of crushing between rollers, according to the system known as the Hungarian or roller system. 2. That we should take a given quantity of each flour so produced and manufacture it into bread. 3. That we should note the qualities and other characteristics of the flours produced, also of the offals, viz., middlings, pollard, and bran. 4. That we should procure the following representative wheats, of fair average quality of the season, as then being sold on Mark Lane market, and, for the purpose of obtaining results for comparison, deal with them precisely as above indicated, both as regards flour, bread, and offals, viz., English average, American (red winter), American (spring), Australian average, California average, Russian Saxonska, Russian Taganrog, Russian Kubanka, Russian Ghirka, Egyptian Buhi, and Egyptian Saida."

The quantity used in each case was 5,000 pounds. The samples varied in weight from 57½ pounds for the Saida Egyptian to 64 pounds for the soft Indian white variety. The weight of the separate "berries" varied greatly; those of American spring were smallest of all, 100 weighing 35.5 grains; winter, 49.6 grains; California, 47.7 grains. The Australian were heaviest, 80.5 grains; Indian, from 51.8 to 77.7 grains. The Saxonska Russian was 37.3 grains, next to American spring the smallest, and containing the most gluten, 23.2 per cent.; yet the size appears to be no indication of the proportion of gluten in other samples, as the heaviest, the Australian, averaged 11.6 per cent., and the poorest in gluten, bearing only 4.4 per cent., was of medium weight, 50.1 for 100.

Wheat.	Value in London per 496 pounds. Net weight on day of valuation.	Weight per bushel.	Impurities removed.	Water absorbed to render mellow.	Yield. Flour.	Yield. Middlings.	Yield. Pollard.	Yield. Bran.	Evaporation and loss.	Gluten by water tests.
	S. d.	*Lbs.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Indian (fine soft white)........	49 0	64	1.52	2.0	77.46	0.82	8.8	12.0	1.40	6.4
Do......	49 0	64	1.52	2.0	74.10	11.00	8.7	4.0	2.68	6.8
Indian (superior soft red)....	45 0	62¾	0.72	3.6	78.40	1.68	9.8	9.4	3.6	9.3
Do..............	45 0	62¾	0.72	3.6	75.4	7.7	13.5	5.3	.98	10.5
Indian (average hard white)..	44 0	60	3.7	8.4	80.52	.78	10.0	8.3	5.1	11.7
Do......................	44 0	60	3.7	8.4	73.2	10.3	14.3	3.1	3.8	12.6
Indian (average hard red).....	43 0	61¼	1.2	7.6	79.88	.78	13.20	8.50	4.04	13.4
Do......................	43 0	61¼	1.2	7.6	74.2	10.3	13.8	3.0	5.1	13.1
English........................	49 0	60½	1.5	None.	65.2	1.1	9.7	17.7	4.8	10.6
Do......................	49 0	60½	1.5	None.	70.3	7.6	7.2	9.2	4.2	11.4
Australian	50 6	62½	1.0	None.	75.8	1.1	7.4	14.4	.3	11.6
Do......................	50 6	62½	1.0	None	75.1	8.0	9.3	5.5	1.1	12.2
New Zealand	48 0	62¾	.3	None.	76.1	.96	8.8	11.5	2.34	10.2
Do......................	48 0	62¾	.3	None.	76.1	7.8	6.6	5.6	3.6	9.0
California	48 0	59¼	1.7	None.	71.1	.72	9.2	15.3	1.98	10.5
Do.......	48 0	59¼	1.7	None.	70.1	14.5	6.3	3.9	3.5	8.7
American (winter)	49 6	61¾	.5	None.	73.8	.38	7.9	16.4	1.02	11.0
Do......................	49 6	61¾	.5	None.	71.5	10.3	11.2	3.1	3.4	11.7
American (spring)............	48 0	61	.9	None.	72.2	.24	7.2	14.7	4.76	15.3
Do.......	48 0	61	.9	None.	69.5	12.1	10.4	3.8	3.3	14.6
Russian (Saxonska)	52 0	60½	.9	None.	73.0	1.2	11.6	12.6	.7	22.1
Do......................	52 0	60½	.9	None.	71.4	12.5	11.7	3.3	.2	23.2
Russian (hard Taganrog).....	49 0	61¼	.8	2.4	76.2	1.2	12.7	8.1	3.4	17.6
Do......................	49 0	61¼	.8	2.4	72.0	9.6	12.1	5.0	2.9	15.6
Egyptian (Buhi)...............	47 0	58	2.7	3.1	72.9	1.0	11.0	10.0	5.5	4.4
Do......................	47 0	58	2.7	3.1	72.6	10.4	8.5	3.5	5.4	7.9
Egyptian (Saida).............	43 6	57½	12.1	2.7	66.9	.76	11.4	7.5	4.04	7.5
Do......................	43 6	57½	12.1	2.7	67.8	7.2	6.5	4.9	4.2	6.6

It will be seen that there were fewest impurities in the New Zealand, Indian soft red, American, and Russian samples.

The manufacture of bread from Indian wheats by the millstone and also the roller process, and from other samples by the roller method, was next undertaken. The quantities used in each case were 280 pounds of flour, 30 pounds of liquid potato ferment, one pound of French yeast, and 3½ pounds of salt. The table is as follows :

Wheat.	Water used.	Yield of bread when cold.	Percentages. Percentage of bread to flour.	Percentages. Percentage of water to flour.	Color, taste, and texture. Color, exterior.	Color, taste, and texture. Color, interior.	Color, taste, and texture. Flavor.	Color, taste, and texture. Texture.	Color, taste, and texture. General characteristics.
	Pounds.	*Pounds.*							
Indian (fine soft white)...............	141.4	364.0	130.0	50.5	10	11	7	8	11
Do	149.6	367.5	131.2	53.4	13	13	9	9	12
Indian (superfine soft white)........	141.6	372.0	133.0	50.6	8	10	7	9	10
Do	148 0	362.0	129.3	52.3	12	13	9	10	11
Indian (average hard white)	141.0	370.5	132.4	50.8	6	7	7	10	7
Do	149.6	365.0	130.3	53.4	10	9	9	10	9
Indian (average hard red)...........	145.2	376.6	134.5	51.8	5	7	7	10	6
Do	147.4	365.0	130.3	52.2	9	9	8	10	8
English	130.0	352.0	125.7	46.4	13	12	13	10	10
Australian	134.2	355.4	126.9	48.0	12	12	12	10	11
New Zealand.......................	132.0	349.0	124.6	47.1	12	12	12	9	10
California	136.8	364.0	130.0	48.9	12	12	12	9	10
American :									
Winter.........................	130.0	346.0	123.5	46.4	13	12	12	10	11
Spring	130.0	354.0	126.4	46.4	8	10	10	12	9
Russian :									
Saxonska.......................	130.0	356.0	127.1	46.4	8	9	9	13	9
Hard Taganrog	145.4	354.5	126.6	51.9	10	11	9	12	9
Egyptian :									
Buhi	136.8	362.0	129.3	48.9	7	6	6	7	5
Saida..........................	144.4	358.0	127.7	51.6	6	4	4	6	4

Whether the Indian wheats were average samples of the product of that country, or a little better through the unconscious partiality of the secretary, may be questionable. They make a good showing for quantity of product, but the *quality* of the soft wheats is quite inferior to that of samples from this country. In the United States, California appears to take the lead in quantity of bread, while the spring wheats of the Northwest not only surpass other American samples in quality, but are unequaled in that respect by any wheats included in this experiment, the Russian only excepted, which excel in gluten.

The following statement relative to the effect of dryness of the grain upon the yield of bread is extracted from this report:

"It is generally believed that upon the percentage of gluten in flour depends the *yield* of bread that may be obtained from it, as illustrated by the Hungarian flours, which are almost unequaled for yield of bread, and rank high in gluten; but this is erroneous, as proved by the experimental workings now under review. It would be found that the flours high in gluten do not produce the most bread, unless, at the same time, they possess a high degree of *dryness*, for it is upon the dryness of the flour that the yield of bread mainly depends, and not upon the gluten. The two lots of flour from Russian wheats (Nos. 11 and 12) are those which are highest in gluten, yet they do not yield as much bread as any of the four Indian wheats (Nos. 1 to 4), and the difference in yield from the latter would have been still further increased had they not been previously mellowed with water, as noted, before milling; confirming that it is the dryness of a flour that determines the yield of bread."

There being considerable doubt as to whether the samples of American wheats in the preceding experiments were representative, a series of baking experiments with flours of various grades from different parts of this country have been carried on in our laboratory with the results which are presented.

The McDougall Brothers found, and it has been confirmed by us, that upon the dryness of a flour, or upon the amount of water which it is possible to add to the dough, depends chiefly the amount of bread which it will yield. Unfortunately no determinations of the amount of moisture in the flours used was made in the English tests.

In our experiments, using the same flour under various conditions, it was found possible to vary the yield of bread per 100 pounds of flour as much as 15 pounds. The conditions upon which this variation depends are largely physical, and include—

Percentage of water used in the dough.

Size of the loaves.

Temperature of the oven.

Time of baking.

Of course in any series of comparative experiments these conditions must be closely observed and regulated. In order to learn the best modifications for our work, a preliminary series was undertaken with a flour from Ohio.

In the beginning it was found that a dough made with any of our flours and as small a percentage of water as was used by the McDougalls would be altogether too stiff for successful results.

In the English experiments with flours from American wheat 46.4 per cent. of water was used, but in our experience it has been found neces-

sary to add on the average about 56 per cent. of water, or water and milk. The result has been that we have obtained a much larger yield of bread per hundred pounds.

The effects of variation in physical conditions are illustrated by the following data:

Variation in yield dependent on percentage of water used (other conditions being the same), on size of loaves, on difference of temperature, and on time of baking.

[Ohio patent flour.]

Dependent on percentage of water used (other conditions being the same).		Dependent on size of loaves.		Dependent on difference of temperature.		Dependent on time of baking.	
Percent. of water.	Yield of bread.	No. of loaves.	Yield of bread.	Temperature.	Yield of bread.	Minutes.	Yield of bread.
54.5	134.5	1 loaf.	138.6	° 249	136.9	50	134.6
58.4	136.9	10 rolls.	129.6	230	140.8	30	140.2
62.1	144.9						
62.1	145.5						

In all these cases the yield is largely modified by the change in a single condition, the remaining ones being constant. It is evident, therefore, how complicated a comparative series of experiments becomes when all the above conditions exercise their modifiying effects and must therefore be kept constant.

There are also conditions of mixing and raising which in a like manner affect the yield. As every one knows, there are different methods of carrying out these operations, and larger or smaller amounts of yeast may be used. The method which we have finally employed is a modification of the Vienna procedure as described by Horsford. The dough is mixed in mass with press yeast and allowed to rise till the outer pellicle is just cracking. It is then rekneaded into loaves, put in pans, and set in a warm place until the dough is again risen, when it is baked.

The baking was carried on in a large gas-stove, the oven of which by means of a thermometer could be kept at a very regular temperature. All the materials used and the products obtained were weighed to 1 gramme (15 grains), so that the results as far as manipulation go may be regarded as accurate.

Having fixed these conditions, as they appear in the table which follows, the experiments were conducted with the different flours which have been collected.

RESULTS OF BAKING EXPERIMENTS.

Name of flour.	Serial number.	Experiment number.	Weight of flour.	Weight of milk.	Weight of water.	Weight of salt.	Weight of yeast.	Relation of water to flour.	Raised.	Loss in rising.	Raised in pans.	Baked.	Temperature of oven.	Bread. Weight, hot.	Bread. Per cent., hot.	Bread. Weight, cold.	Bread. Per cent., cold.	Per cent. of moisture.	Per cent. of nitrogen.	Per cent. of albumen.	Gluten. Per cent. of, moist.	Gluten. Per cent. of dry.
													° C.									
Maryland Patent Flour	2593	18	2, 032	500	650	25	10	56. 59	2° 35′	12	1° 07′	45′	......	2, 856	140. 6	2, 729	134. 4	11. 55	1. 65	10. 33	33. 32	9. 60
		31	2, 049	500	650	25	10	56. 12	3° 00′	30	1° 00′	45′	228	2, 933	143. 2	2, 795	136. 4					
Maryland Straight	2800	21	2, 014	500	650	25	10	57. 09	2° 56′	28	1° 06′	45′	......	2, 937	145. 8	2, 754	136. 7	11. 08	1. 75	10. 94	32. 49	10. 28
		34	2, 031	500	650	25	10	56. 62	2° 45′	23	1° 00′	50′	248	2, 866	141. 1	2, 746	135. 2					
Maryland Low Grade	2808	24	2, 024	500	650	25	10	56. 82	2° 35′	18	55′	45′	243	2, 846	140. 6	2, 740	135. 4	12. 78	1. 84	11. 50	30. 15	11. 13
		37	2, 024	500	650	25	10	56. 82	2° 45′	32	1° 00′	55′	243	2, 859	141. 3	2, 759	136. 3					
District of Columbia Patent	2821	43	2, 073	500	650	25	10	55. 48	2° 30′	59	1° 00′	45′	236	2, 873	138. 6	2, 754	132. 9	12. 98	1. 46	9. 10	31. 58	9. 09
		47	2, 056	500	650	25	10	55. 93	3° 00′	36	1° 00′	45′	230	2, 833	137. 8	2, 732	132. 9					
District of Columbia Straight	2820	42	2, 045	500	650	25	10	56. 23	2° 30′	38	1° 00′	45′	245	2, 867	140. 2	2, 757	134. 8	12. 38	1. 53	9. 56	33. 40	9. 76
		46	2, 030	500	650	25	10	56. 65	2° 30′	31	1° 00′	45′	235	2, 830	139. 4	2, 730	134. 5					
Straight Virginia	2591	14	2, 033	500	650	25	10	56. 57	2° 35′	12	55′	30′	......	2, 948	145. 0	......	......	12. 16	1. 93	12. 08	36. 07	11. 41
		16	2, 044	500	650	25	10	56. 26	2° 41′	19	1° 02′	45′	......	2, 886	141. 2	2, 792	136. 6					
		29	2, 025	500	650	25	10	56. 79	2° 45′	21	1° 00′	45′	248	2, 931	144. 7	2, 808	138. 7					
Low Grade Virginia	2807	23	2, 032	500	650	25	10	56. 59	2° 57′	17	1° 15′	45′	247	2, 898	142. 6	2, 785	137. 1	11. 77	2. 02	12. 60	36. 81	11. 60
		36	2, 038	500	650	25	10	56. 43	2° 40′	28	1° 00′	45′	248	2, 870	140. 8	2, 738	134. 3					
Roller Patent, Virginia	2805	28	2, 034	500	650	25	10	56. 54	2° 35′	11	1° 07′	45′	248	2, 838	139. 5	2, 733	134. 4	12. 10	1. 73	10. 81	37. 89	11. 08
		41	2, 047	500	650	25	10	56. 19	2° 55′	34	1° 00′	45′	230	2, 914	142. 4	2, 781	135. 9					
Ohio Patent	2190	11	2, 149	500	650	25	10	53. 51	3° 16′	32	1° 15′	48′	......	2, 986	138. 8	......	......	12. 85	1. 70	10. 62	29. 63	10. 47
		12	2, 110	500	650	25	10	54. 50	......	24	......	50′	......	2, 989	141. 7	2, 840	134. 6					
Indiana Patent	2822	44	2, 049	500	650	25	10	56. 12	2° 35′	31	1° 35′	45′	240	2, 908	141. 4	2, 780	135. 7	12. 33	1. 59	9. 94	33. 60	10. 03
		48	2, 068	500	650	25	10	55. 61	2° 50′	35	1° 00′	50′	230	2, 898	140. 1	2, 772	134. 0					
Illinois Patent Flour	2594	19	2, 041	500	650	25	10	56. 35	2° 35′	4	55′	45′	......	2, 914	142. 8	2, 791	136. 8	12 00	1. 93	12. 08	37. 36	11. 56
		32	2, 043	500	650	25	10	56. 29	2° 47′	19	1° 00′	45′	232	2, 862	140. 1	2, 754	134. 8					
Wisconsin Straight	2801	22	2, 035	500	650	25	10	56. 51	2° 50′	28	55′	45′	......	2, 832	139. 2	2, 730	134. 2	12. 37	1. 60	9. 98	28. 39	9. 56
		35	2, 031	500	650	25	10	56. 62	2° 30′	29	1° 00′	45′	245	2, 852	140. 4	2, 728	134. 3					
Roller Patent, Wisconsin	2806	27	2, 034	500	650	25	10	56. 54	2° 52′	13	1° 00′	45′	249	2, 900	142. 6	2, 788	137. 1	13. 25	1. 85	11. 55	34. 45	10. 65
		40	2, 040	500	650	25	10	56. 37	2° 30′	33	1° 00′	45′	234	2, 862	140. 3	2, 745	134. 1					
Best Minnesota Patent Process	2592	15	2, 033	500	650	25	10	56. 57	2° 35′	28	55′	30′	......	2, 951	145. 2	......	......	12. 82	1. 90	11. 90	39. 18	11. 98
		17	2, 028	500	650	25	10	56. 71	2° 43′	18	57′	45′	......	2, 825	139. 3	2, 747	135. 5					
		30	2, 024	500	650	25	10	56. 82	2° 30′	23	1° 00′	45′	242	2, 802	138. 4	2, 784	137. 6					
Minnesota Low Grade	2599	20	2, 006	500	650	25	10	57. 33	2° 37′	13	1° 00′	45′	......	2, 915	145. 3	2, 807	139. 9	12. 05	2. 51	15. 69	34. 22	14. 06
		33	2, 029	500	650	25	10	56. 68	3° 05′	26	1° 00′	45′	234	2, 886	142. 2	2, 786	137. 3					
Minnesota Bakers'	2803	26	2, 024	500	650	25	10	56. 82	2° 35′	21	1° 00′	45′	246	2, 885	142. 5	2, 742	135. 5	11. 77	1. 95	12. 19	36. 71	11. 71
		39	2, 031	500	650	25	10	56. 6[illegible]	2° 40′	32	1° 00′	45′	238	2, 928	144. 2	2, 803	138. 0					
Roller Patent, Missouri	2804	25	2, 059	500	650	25	10	55. 85	2° 43′	31	1° 00′	50′	248	2, 846	138. 2	2, 738	133. 0	12. 04	1. 67	10. 44	32. 24	9. 23
		38	2, 042	500	650	25	10	56. 32	2° 45′	39	1° 00′	45′	242	2, 859	140. 1	2, 746	134. 5					
New Process Oregon	2824	45	2, 085	500	650	25	10	55. 16	2° 40′	41	1° 00′	45′	240	2, 873	137. 8	2, 689	129. 0	14. 03	1. 15	7. 18	20. 84	6. 75
		49	2, 087	500	650	25	10	55. 10	2° 30′	24	1° 05′	45′	240	2, 883	138. 1	2, 753	132. 0					

The results are variable within limits which are so narrow as to make it impossible to say that one flour will make much more bread than another, and it will be observed that the lowest grade gives as large a yield, or even larger, than the best patent. If, however, the moisture in the flour had been less uniform our results would probably show a larger yield of bread for the drier flours. The conclusion must be then that the yield is dependent on physical conditions of bread-making, and not to a large extent upon the chemical composition of the wheat. In all our experiments we get a much larger percentage of bread than the McDougalls, but it is due to the possibility of the use of larger amounts of water in the dough. In other respects their conclusions are confirmed that water is the chief conditioning agent, and that the per cent. of gluten has but little effect upon the yield.

That it has some, however, appears from the fact that the largest yield was obtained with a Minnesota low-grade flour, having the highest gluten of any experimented with, and the lowest yield was from the Oregon flour, having the smallest amount. The bread from the low-grade flour mentioned, although the heaviest yield, was dark and of the worst quality; that from the Oregon flour was white and fair. These flours are very peculiar, and in another place a few remarks are made upon their composition.

Aside from quantity the quality of the bread made from Minnesota patent flours is certainly as near perfect as could be wished. That from other patent flours suffers slightly in comparison, while, of course, the bread from straight flours, bakers', and low grade, cannot compare with that from patents.

CORN (MAIZE).

The average composition of corn from the various States, derived from the analyses published in a previous bulletin, differed very slightly in their percentages of albuminoids. The observations upon this cereal during the past year have been confined, therefore, to determinations of nitrogen and ash in a number of samples from localities from which none had been previously received, and to taking the weights of one hundred kernels of specimens from all parts of the country.

ANALYSES OF AMERICAN CORN BY STATES.

Variety.	Serial number.	Ash.	Albuminoids.	Nitrogen.
New York:		*Per cent.*	*Per cent.*	*Per cent.*
Yellow Flint	2393	1.41	9.80	1.57
Do	2394	1.54	12.43	1.99
Do	2395	1.21	9.28	1.48
Do	2396	1.45	9.10	1.46
Do	2397	1.24	9.45	1.51
Do	2399	1.50	10.85	1.74
Do	2400	1.51	10.68	1.71
Do	2402	1.50	10.85	1.74
Do	2403	1.47	12.43	1.99
Illinois:				
Red Dent	2330	1.27	8.75	1.40
White Dent	2331	1.72	12.08	1.93
Do	2332	1.50	10.68	1.71
Yellow Dent	2333	1.37	10.50	1.68
Do	2336	1.52	11.38	1.82

ANALYSES OF AMERICAN CORN BY STATES—CONTINUED.

Variety.	Serial number.	Ash.	Albuminoids.	Nitrogen.
Illinois—Continued.		*Per cent.*	*Per cent.*	*Per cent.*
White Dent	2337	1.15	8.40	1.34
Red Dent	2341	1.40	10.33	1.65
White Dent	2343	1.36	8.05	1.29
Yellow Dent	2344	2.60	10.33	1.65
Do	2347	1.32	9.28	1.48
Do	2348	1.59	11.38	1.82
Do	2349	1.35	11.20	1.79
Do	2351	1.17	8.40	1.34
Do	2352	1.22	9.80	1.57
White Dent	2353	1.50	10.33	1.65
Yellow Dent	2356	1.85	11.03	1.76
White Dent	2362	1.58	10.33	1.65
Yellow Dent	2365	1.48	10.15	1.62
Red Dent	2366	1.43	7.88	1.26
White Dent	2368	1.30	10.85	1.74
Minnesota:				
Yellow Dent	1989	1.84	10.85	1.74
Do	1990	1.85	12.43	1.99
Do	1991	1.63	11.20	1.79
White Dent	1992	1.39	9.10	1.46
Yellow Flint	1993	1.74	11.03	1.76
Yellow Dent	1994	1.66	9.80	1.57
White Dent	1995	1.51	9.45	1.51
Yellow Dent	1996	1.73	8.75	1.40
Yellow Flint	1997	1.61	9.80	1.57
Yellow Dent	1998	1.65	9.80	1.57
Do	1999	1.66	10.85	1.74
Do	2202	2.02	8.40	1.34
Do	2203	1.57	9.80	1.57
Red Flint	2204	1.49	9.10	1.46
Mixed Dent	2211	1.78	10.50	1.68
White Dent	2217	1.73	10.33	1.65
Dakota:				
White Dent	2307	1.48	10.33	1.65
Red Dent	2308	1.83	11.38	1.82
Yellow Dent	2309	1.88	11.38	1.82
White Dent	2310	1.55	11.03	1.76
Yellow Dent	2311	1.71	10.68	1.71
Do	2312	1.36	9.63	1.54
Do	2313	1.39	11.20	1.79
Mixed Flint	2314	1.35	10.85	1.74
Yellow Dent	2315	1.96	12.25	1.96
Do	2318	1.71	11.03	1.76
White Dent	2320	1.47	10.33	1.65
Yellow Dent	2321	1.47	9.28	1.48
Red Dent	2322	1.03	11.03	1.76
Do	2325	1.84	10.33	1.65
Do	2328	1.51	10.50	1.68
Nebraska:				
Yellow Dent	2371	1.59	10.15	1.62
Do	2373	1.60	10.33	1.65
Do	2374	1.48	9.80	1.57
Do	2375	1.43	10.50	1.68
Mixed Dent	2376	2.01	9.10	1.46
Yellow Dent	2378	1.37	9.45	1.51
Do	2379	1.50	11.90	1.90
Do	2380	1.64	11.55	1.85
Do	2381	1.63	11.73	1.88
Do	2382	1.43	9.63	1.54
Mixed Dent	2385	1.45	9.63	1.54
Yellow Dent	2386	1.40	12.25	1.96
Do	2388	1.51	10.15	1.62
Colorado:				
Yellow Dent	1985	1.92	9.10	1.46
White Dent	1986	3.08	12.25	1.96
Yellow Dent	1987	2.06	9.28	1.48
Do	1988	1.85	8.93	1.43
California:				
White Flint	2296	1.70	11.73	1.88
Yellow Dent	2297	1.35	9.80	1.57
White Dent	2298	1.80	11.73	1.88
Yellow Dent	2299	1.41	8.40	1.34
White Dent	2300	1.68	11.38	1.82
Yellow Dent	2301	1.46	10.68	1.71
Mixed Dent	2302	1.59	9.63	1.54
White Dent	2303	1.54	9.63	1.54
Do	2304	1.58	10.33	1.65
Do	2305	1.63	9.80	1.57
Yellow Dent	2306	1.45	9.80	1.57

ANALYSES OF CORN FROM OTHER SOURCES THAN THE DEPARTMENT OF AGRICULTURE, ARRANGED BY STATES.

Name.	Variety.	Date.	Water.	Ash.	Oil.	Carbhydrates.	Fibre.	Albuminoids.	Nitrogen.	Analyst.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	
Massachusetts:										
Waushakum	Flint		13.05	1.29	4.06	69.80	1.11	10.69	1.71	United States Census.
Wheeler's Prolific	do		12.69	1.39	4.58	67.46	1.82	12.06	1.93	Massachusetts Rep't, 1879.
Clark	do		12.12	1.64	4.75	66.91	2.46	12.12	1.94	Do.
Tip	do		8.86	1.57	5.26	68.93	2.53	12.85	2.06	Do.
Canada	do		13.44	1.27	4.56	66.31	2.40	12.02	1.92	Do.
Canada Dutton	do		14.36	1.42	5.00	66.51	2.38	10.33	1.65	Do.
Massachusetts Red	do		11.95	1.10	3.40	69.47	2.02	12.06	1.93	Sharples.
Massachusetts White	do		10.22	1.44	3.40	74.24	1.47	9.22	1.48	Do.
Early Southern	Dent		12.97	1.64	4.83	66.62	2.41	11.54	1.85	Massachusetts Rep't, 1879.
Golden Eight-rowed	Uncla		12.51	1.58	4.94	69.37	1.35	10.25	1.64	Sharples.
Connecticut:										
White Pop-corn	Flint	1876	11.84	1.24	4.92	71.09	1.22	9.69	1.55	United States Census.
King Philip	do		15.97	1.35	4.50	66.50	1.37	10.31	1.65	Connecticut Report, 1880.
Common Yellow	do		15.77	1.26	4.44	67.06	1.47	10.00	1.60	Do.
White	do		16.82	1.19	3.89	67.84	1.32	8.94	1.43	Do.
Early Scioto	Dent		15.24	1.28	3.80	69.78	1.59	8.31	1.33	Do.
New York, White, Yellow Pop-corn	Flint	1879	12.55	1.28	4.18	70.49	1.16	10.34	1.65	United States Census.
South Carolina, Southern White	do		9.86	1.37	4.48	69.78	2.03	12.47	2.00	Massachusetts Rep't, 1879.
Illinois:										
Western White	Dent		10.77	1.35	4.23	69.72	2.47	11.46	1.83	Do.
Western Yellow	do		11.90	1.41	4.46	68.39	2.95	10.89	1.74	Do.
	Unclassified		13.61	1.35	3.62	69.10	3.13	9.19	1.47	Sharples.
Minnesota, Yellow Dent	Dent		12.14	1.63	4.25	70.86	1.62	9.50	1.52	United States Census.
New Mexico:										
White	Unclassified	1879	10.92	1.58	5.59	70.10	1.75	10.06	1.61	Do.
Red	do	1879	10.85	1.60	5.89	68.97	1.60	11.09	1.77	Do.
California, Yellow Dent	Dent	1879	11.42	1.37	5.18	69.16	1.56	11.31	1.81	Do.
Unclassified:										
Western corn	Unclassified		20.68	1.19	3.70	64.95	1.65	7.83	1.25	Connecticut Report, 1880.
Do	do		20.22	1.16	3.55	64.86	1.67	8.54	1.37	Do.
Do	do		16.41	1.25	3.85	68.16	1.76	8.57	1.37	Do.
Kansas corn	do		11.34	1.07	4.60	72.90	1.28	8.81	1.41	Sharples.
Sweet corn:										
Blue Texas	Massachusetts		7.74	1.60	8.70	65.54	2.56	13.86	2.22	Massachusetts Rep't, 1879.
Crosby	do		10.50	1.77	6.91	66.75	2.47	11.60	1.86	Do.
Sweet	Connecticut	1877	10.09	2.08	8.22	61.78	2.52	15.31	2.45	Connecticut Report, 1878.
Burr's Sweet	Sweet		10.68	2.22	7.77	62.70	4.94	11.69	1.87	Sharples.

AVERAGE COMPOSITION OF AMERICAN CORN.

	Ash.	Albuminoids.	Nitrogen.	Number of analyses.	Lowest albuminoids.	Highest albuminoids.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*
America, 1882	1.52	10.46	1.67	114	7.00	13.05
America, 1883	1.58	10.31	1.65	88	7.88	12.63
Average	1.55	10.39	1.66	202	7.00	13.65
New York	1.43	10.54	1.69	9	9.10	12.43
Illinois	1.48	10.06	1.61	20	7.88	12.08
Minnesota	1.68	10.07	1.61	16	8.40	12.43
Dakota	1.57	10.75	1.72	15	9.28	12.25
Nebraska	1.54	10.47	1.68	13	9.10	12.25
Colorado	2.23	9.89	1.58	4	8.93	12.25
California	1.56	10.26	1.64	11	8.40	11.73

Among the determinations of the ash and nitrogen in the crop of 1883, given in the preceding tables, there is as little variation as in previous analyses, and the conclusions derived from the latter are confirmed.

The average of all the determinations for each year and for both together vary only in the hundredths of a per cent.

Corn may be said, therefore, without doubt, to be very constant in its composition within narrow limits.

An occasional exception will no doubt appear, as is the case of the ash in serial No. 1986, from Colorado, which rises to 3.08 per cent., but among over two hundred analyses this is hardly remarkable.

The averages for the States, as would be expected, agree well. Colorado is represented by only four specimens, which happen to be below the average, while California, represented by eleven, raises the average for the Pacific slope, which, in the previous report, after the analyses of two specimens from Oregon, appeared very low.

Such analyses by other investigators as have been collected since the appearance of the last bulletin on this subject appear here in a table by themselves. The results there given coincide with our own.

WEIGHT OF KERNELS OF CORN IN DIFFERENT PORTIONS OF THE COUNTRY.

Previous results showed that corn varied in weight from 53 grains per hundred kernels to 23 grains, averaging about 37. How far locality and surroundings influenced this has been to a degree determined by the examination of specimens collected by the agents of the Department from all parts of the Union. The results are here tabulated:

CORN, WEIGHT OF 100 KERNELS.

State and county.	Serial number.	Variety.	Color.	Weight.
Maine:				*Grams.*
Cumberland	11	Flint	Yellow	41.7080
Franklin	12	...do	...do	21.3015
Kennebec	2	...do	...do	29.9492
Knox	13	...do	...do	37.0640
Lincoln	4	...do	...do	23.4490
Waldo	15	...do	...do	29.4690
New Hampshire:				
Coos	8	Flint	Yellow	17.7670
Vermont:				
Chittenden	12	Flint	Yellow	30.1690
Grand Isle	9	...do	...do	26.6350
Massachusetts:				
Barnstable	5	Flint	Yellow	46.9374
Berkshire	8	...do	...do	28.7824
Bristol	11	...do	White	51.7450
Franklin	2	...do	Yellow	31.6586
Hampshire	12	...do	...do	37.0370
Connecticut:				
Hartford	5	Flint	Yellow	37.6470
New York:				
Albany	6	Flint	Yellow	23.3870
Alleghany	7	...do	...do	28.4944
Cattaraugus	31	...do	...do	28.0286
Chenango	58	...do	...do	27.8850
Do	58*a*	...do	...do	23.6990
Cortland	37	...do	...do	25.0720
Delaware	38	...do	...do	37.0530
Do	38*a*	...do	...do	26.9430
Dutchess	13	...do	...do	33.5348
Fulton	21	...do	...do	23.5986
Greene	41	...do	...do	32.4170
Herkimer	10	...do	...do	18.6986
Jefferson	59	...do	White	40.7960
Niagara	29	...do	Yellow	34.3590
Oneida	26	...do	...do	28.7130
Ontario	17	...do	...do	22.2445
Orange	32	...do	...do	39.2240
Orleans	46	...do	White and red	30.9220
Oswego	15	...do	Yellow	21.3620
Queens	48	Dent	Mixed	33.3200
Do	48*a*	Flint	Yellow	43.1110
Saratoga	28	...do	...do	25.9930
Steuben	25	...do	...do	39.1112
Tioga	30	...do	...do	33.6786
Warren	8	...do	...do	34.5152
Washington	55	...do	do	32.4880
Do	55*a*	...do	White and red	29.8690
Yates	19	...do	Yellow	35.9108
Pennsylvania:				
Beaver	35	Dent	Streaked	40.1450
Bradford	37	Flint	Yellow	35.6170
Centre	41	Dent	...do	32.8630
Clinton	42	...do	...do	31.8490
Columbia	43	...do	...do	33.3530
Delaware	45	...do	...do	27.4900
Indiana	49	...do	...do	41.3560
Do	49*a*	...do	Reddish yellow	39.5540
Lawrence	51	...do	Yellow	34.2990
Lebanon	52	...do	...do	38.4480
Luzerne	53	Flint	...do	43.7330
Montour	55	Dent	...do	33.0520
Northumberland	56	...do	Mixed	34.1260
Warren	62	Flint	Flesh	35.9790
York	34	Dent	Mixed	32.8140
New Jersey:				
Camden	4	Dent	Yellow	44.1740
Gloucester	8	...do	...do	56.6640
Hunterdon	9	...do	...do	35.7330
Middlesex	10	...do	...do	38.4360
Morris	12	...do	Mixed	46.4710
Salem	14	Flint	Yellow	27.5740
Sussex	15	...do	White	46.2980
Maryland:				
Alleghany	1	Dent	Yellow	43.7790
Calvert	4	...do	White	34.6020
Do	4*a*	...do	...do	58.1560
Caroline	5	...do	...do	34.0010
Carroll	6	...do	Yellow	40.0420
Cecil	20	...do	...do	42.4790

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Maryland—Continued.				Grams.
Charles	7	Dent	White	40.0370
Dorchester	8	....do	....do	37.4100
Frederick	9	....do	Yellow	40.0550
Harford	11	....do	... do	42.2500
Do	11a	....do	White	52.5360
Montgomery	21	Flint	... do	54.4970
Prince George's	14	Dent	....do	43.7740
Somerset	16	... do	....do	43.1300
Talbot	17	....do	....do	43.7140
Wicomico	23	....do	... do	44.7030
Do	23a	Flint	....do	36.0350
Virginia:				
Albemarle	1	Dent	White mixed	40.3250
Amelia	3	... do	Yellow	47.3190
Amherst	4	... do	White	40.4620
Do	4a	... do	do	54.5600
Do	4b	....do	Mixed	42.6400
Carroll	16	.. do	White mixed	44.6700
Chesterfield	17	....do	White	39.7620
Craig	21	... do	White mixed	36.3600
Culpeper	22	....do	.. do	24.1600
Cumberland	23	....do	White	42.8920
Dickinson	95	....do	... do	49.1290
Dinwiddie	24	....do	....do	36.1750
Elizabeth City	25	....do	....do	39.7920
Essex	26	....do	....do	32.6440
Fairfax	27	....do	Yellow	36.5730
Floyd	28	....do	White	45.0670
Franklin	30	... do	....do	57.7960
Frederick	31	... do	... do	56.1340
Giles	32	....do	... do	47.1150
Goochland	34	....do	....do	43.6840
Grayson	97	....do	....do	44.8550
Halifax	37	....do	....do	45.7640
Hanover	38	....do	....do	39.2180
Do	38a	... do	....do	31.0440
Henry	40	....do	....do	40.7340
James City	43	do	... do	45.3530
King and Queen	44	Dent and Flint	... do	28.0200
Madison	51	Dent	White mixed	43.4240
Matthews	52	... do	White	51.1540
Mecklenburgh	53	....do	....do	45.0450
Middlesex	54	....do	....do	48.1860
Nansemond	56	....do	... do	47.8900
Do	56a	... do	... do	38.9440
New Kent	58	... do	... do	43.9690
Northumberland	61	.. do	....do	52.3760
Orange	63	... do	....do	47.6080
Patrick	65	... do	... do	45.0470
Pittsylvania	66	.. do	Mixed	49.1400
Prince Edward	68	.. do	White	38.2870
PrinceGeorge	69	... do	... do	47.7460
Prince William	71	....do	... do	27.7990
Princess Anne	70	... do	... do	41.5230
Pulaski	72	... do	... do	28.7950
Rappahannock	73	....do	White mixed	40.5660
Richmond	74	....do	White	40.6070
Roanoke	75	... do	....do	50.9770
Russell	78	....do	Yellow and white	46.2350
Smyth	80	... do	Flesh	47.9130
Southampton	82	... do	White	41.1850
Sussex	85	Dent and Flint	....do	40.4520
Tazewell	86	Dent	Yellow	33.6390
Warren	87	....do	....do	48.8820
Do	87a	....do	White	47.8720
Warwick	88	... do	....do	32.6330
Washington	89	....do	....do	59.7100
Westmoreland	90	... do	White mixed	41.4490
West Virginia:				
Barbour	1	Dent	Yellow	40.1420
Berkeley	2	....do	....do	27.6300
Do	2a	....do	....do	43.5130
Brooke	4	....do	... do	49.7770
Doddridge	6	....do	White	44.9690
Fayette	7	....do	... do	43.9520
Greenbrier	10	....do	Yellow	33.9000
Hancock	12	....do	....do	31.8860
Hardy	13	....do	White	40.0250
Jackson	15	....do	Yellow	34.7280

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
West Virginia—Continued.				*Grams.*
Jackson	15*a*	Dent	Yellow	32.6170
McDowell	18	...do	White mixed	49.3900
Marshall	20	...do	Yellow	45.3850
Mason	21	...do	...do	41.3260
Monongalia	24	...do	...do	44.3150
Monroe	25	...do	White	38.4160
Nicholas	27	...do	Striped	33.4580
Ohio	28	...do	Yellow	38.1590
Pleasants	30	...do	...do	48.2560
Preston	32	...do	...do	26.7720
Ritchie	36	...do	...do	37.4180
Roane	37	...do	...do	40.3030
Tucker	40	...do	...do	31.2220
Tyler	41	...do	...do	36.8050
Wayne	43	...do	...do	32.6810
Wetzel	45	...do	...do	42.0710
Wyoming	46	...do	...do	50.8620
Kentucky:				
Allen	2	Dent	White	41.9820
Barren	4	...do	...do	47.8830
Butler	98	...do	...do	43.7350
Casey	100	...do	White mixed	45.3870
Clay	16	...do	White	60.9090
Clinton	17	...do	...do	41.4830
Cumberland	19	...do	...do	37.2330
Do	19*a*	...do	...do	39.6580
Fayette	22	...do	...do	36.4460
Floyd	103	...do	White mixed	38.2890
Franklin	23	...do	...do	32.0040
Fulton	104	...do	White	36.9570
Gallatin	11	...do	...do	41.6640
Grayson	28	...do	...do	48.6780
Hardin	32	...do	Striped	42.8270
Harlan	33	...do	Mixed	42.8230
Harrison	34	...do	Yellow	39.1370
Hopkins	38	...do	White	28.0280
Jessamine	39	...do	...do	45.8660
Knox	42	...do	White mixed	46.3940
Laurel	43	...do	...do	43.2910
Lawrence	44	...do	White	35.5860
Lee	108	...do	White mixed	43.7520
Letcher	45	...do	Yellow	39.5360
Lewis	46	...do	...do	40.2680
Livingston	48	...do	White	41.9730
McLean	51	...do	...do	33.1090
Madison	52	...do	White mixed	52.3770
Do	52*a*	...do	Yellow	43.6300
Marion	54	...do	Striped	39.1000
Menifee	59	...do	White mixed	57.2070
Metcalfe	61	...do	White	42.2090
Monroe	62	...do	Flesh	48.4790
Muhlenburgh	65	...do	White	36.6180
Nelson	66	...do	...do	44.9670
Nicholas	67	...do	...do	54.6140
Ohio	68	Flint	...do	39.7160
Do	68*a*	Dent	...do	46.9460
Owen	70	...do	White mixed	36.4080
Owsley	71	...do	White	57.0970
Perry	73	...do	Flesh	41.2540
Powell	75	...do	White	35.5160
Robertson	76	...do	...do	38.7770
Rock Castle	77	...do	White mixed	49.9940
Russell	79	...do	Flesh	43.2690
Scott	80	...do	White	41.4460
Simpson	112	...do	Flesh	42.8850
Spencer	82	...do	White	44.9200
Do	82*a*	...do	Yellow	40.9050
Trimble	12	...do	White	41.3980
Do	86	...do	...do	52.3830
Union	87	...do	...do	42.4130
Washington	88	...do	...do	36.5500
Wayne	89	...do	...do	34.4170
Woodford	91	...do	Yellow	31.6230
Tennessee:				
Anderson	1	Dent	White	48.1260
Bedford	2	...do	Yellow	34.9680
Blount	5	...do	White	43.5470
Bradley	6	...do	...do	63.3840
Campbell	7	...do	...do	49.5090

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Tennessee—Continued.				*Grams.*
Cannon	8	Dent	Red	44.7720
Carroll	9	...do	White	37.3520
Carter	10	...do	...do	39.9900
Chatham	11	...do	Yellow	36.2570
Claiborne	12	...do	White	48.7480
Cumberland	16	...do	White mixed	41.2220
Davidson	17	...do	White	48.6310
Dyer	21	...do	...do	46.9320
Fayette	22	...do	White mixed	38.9430
Fentress	23	...do	White and yellow	43.3210
Franklin	24	...do	White mixed	50.9990
Gibson	25	...do	White	55.6140
Giles	26	...do	...do	42.1770
Do	26*a*	...do	...do	64.1020
Grainger	27	...do	...do	50.8800
Greene	28	...do	...do	32.9000
Do	28*a*	...do	...do	48.5940
Hamilton	29	...do	...do	57.8120
Hancock	30	...do	...do	38.8760
Hawkins	33	...do	...do	30.7400
Henderson	35	...do	...do	37.0890
Henry	36	...do	...do	31.4500
James	40	...do	...do	43.6350
Jefferson	41	...do	...do	52.3530
Lake	44	...do	...do	61.1410
Lauderdale	45	...do	...do	29.6330
Lewis	47	...do	...do	53.5600
Lincoln	48	...do	...do	42.9770
Loudon	49	...do	...do	47.2660
McMinn	50	...do	...do	47.5200
Madison	51	...do	...do	45.9660
Meigs	54	...do	White mixed	48.9620
Monroe	55	...do	...do	50.3840
Obion	59	...do	White	44.3210
Perry	61	...do	...do	49.7720
Pickett	63	...do	...do	36.5040
Polk	62	...do	...do	45.5760
Rhea	65	...do	...do	48.7750
Robertson	67	...do	...do	46.6970
Rutherford	68	...do	...do	37.1160
Scott	96	...do	...do	47.9150
Sequatchie	69	...do	...do	34.6750
Do	69*a*	...do	...do	40.8140
Sevier	70	...do	...do	51.0940
Shelby	71	...do	Red and yellow	42.0800
Stewart	73	...do	White	40.5950
Sullivan	74	...do	...do	46.6280
Sumner	75	...do	Yellow	39.2230
Tipton	76	...do	Mixed	45.6770
Unicoi	78	...do	White	42.9740
Do	78*a*	...do	...do	43.3720
Warren	81	...do	...do	49.2900
Washington	82	...do	...do	44.4180
White	85	...do	...do	56.4240
Wilson	87	...do	White mixed	50.7800
North Carolina:				
Alamance	1	Dent	White	36.8990
Alexander	2	...do	...do	47.2170
Alleghany	3	...do	...do	44.0060
Ashe	5	Dent and Flint	...do	33.2440
Beaufort	6	Dent	Yellow	47.5080
Bertie	7	...do	White	37.8140
Burke	10	...do	...do	33.2530
Cabarrus	11	...do	...do	42.7960
Caldwell	12	...do	...do	31.4350
Carteret	14	...do	Yellow mixed	37.6820
Chatham	17	...do	White	42.5690
Cherokee	18	...do	...do	42.0380
Chowan	19	...do	...do	47.0040
Clay	20	...do	...do	45.7720
Cleveland	21	...do	...do	36.6050
Craven	23	...do	...do	38.9610
Cumberland	24	...do	...do	35.1720
Currituck	25	...do	...do	52.4550
Do	25*a*	...do	...do	59.9280
Duplin	29	...do	...do	32.2610
Do	29*a*	...do	...do	47.3880
Edgecombe	30	...do	...do	41.2440
Forsyth	31	...do	...do	42.0760

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
				Grams.
North Carolina—Continued.				
Franklin	32	Dent	White	30.1630
Gaston	33	...do	Mixed	37.6070
Gates	34	...do	White	48.7780
Greene	37	...do	White mixed	44.8060
Halifax	39	...do	White	54.8920
Harnett	40	...do	...do	37.6740
Henderson	42	...do	White mixed	45.8500
Iredell	43	...do	White	35.4980
Jackson	44	...do	...do	49.1170
Johnston	45	...do	...do	34.4790
Do	45*a*	...do	Mixed	37.1270
Jones	46	...do	...do	38.8420
Lenoir	47	...do	...do	41.1470
Macon	50	...do	White	44.3440
Madison	51	...do	...do	50.1250
Moore	56	...do	...do	37.6320
New Hanover	58	...do	...do	43.7400
Do	58*a*	...do	Yellow mixed	41.6500
Pamlico	61	...do	White	44.7080
Pasquotank	62	...do	...do	40.6100
Pender	63	...do	...do	30.1470
Polk	66	...do	...do	44.6580
Randolph	67	...do	...do	50.8030
Richmond	68	...do	Yellow	39.4120
Rowan	70	...do	White	43.8960
Rutherford	71	...do	...do	34.3190
Stokes	73	...do	...do	55.1340
Surry	74	...do	...do	48.4200
Swain	75	...do	...do	60.5360
Transylvania	76	...do	...do	48.5150
Union	78	...do	Mixed	42.2620
Wake	79	...do	White	40.3820
Wilkes	82	...do	Yellow mixed	44.6350
Wilson	83	...do	White	42.1510
Yadkin	84	...do	...do	42.6170
Yancey	85	...do	...do	44.6010
South Carolina:				
Aiken	2	Dent	White	37.5570
Barnwell	3	...do	White mixed	31.9770
Beaufort	4	Flint	White	27.1930
Charleston	6	Dent	...do	27.9010
Clarendon	9	Flint	...do	31.5070
Colleton	10	Dent	...do	34.9150
Georgetown	14	Flint	...do	39.1870
Lancaster	19	Dent	...do	24.2640
Lexington	20	...do	...do	42.4720
Marion	21	...do	...do	28.7250
Newberry	23	...do	White and yellow	34.6620
Oconee	24	...do	White	42.2610
Orangeburgh	25	...do	...do	43.2870
Pickens	26	...do	...do	54.6680
Richland	27	...do	...do	46.1000
Spartanburgh	28	...do	...do	35.5490
Williamsburgh	31	...do	...do	40.5140
York	32	...do	Yellow	43.0170
Georgia:				
Banks	4	Dent	White	37.0870
Do	4*a*	...do	...do	47.8510
Berrien	6	...do	...do	34.5660
Brooks	8	...do	Mixed	30.6540
Bulloch	10	...do	...do	35.3600
Campbell	14	...do	White mixed	27.0600
Carroll	15	...do	White	30.9250
Catoosa	16	...do	White mixed	41.1230
Cherokee	21	...do	...do	40.0660
Clarke	22	...do	...do	35.0520
Clayton	44	...do	White	42.5320
Clinch	25	...do	White mixed	34.0820
Cobb	26	Flint	White	25.4800
Coffee	27	Dent	...do	41.4550
Colquitt	28	...do	...do	51.1090
Dawson	33	...do	...do	39.2370
Dooly	36	...do	White mixed	28.9600
Early	38	...do	...do	30.2580
Effingham	40	...do	White	28.6630
Elbert	41	...do	White mixed	40.2650
Emanuel	42	...do	Mixed	25.1970
Fannin	43	...do	White	47.2580
Floyd	45	...do	Mixed	40.2010

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Georgia—Continued.				*Grams.*
Forsyth	46	Dent	White mixed	39.0430
Franklin	47	...do	White	63.1250
Fulton	48	...do	...do	55.4030
Do	24	...do	...do	37.8450
Gilmer	49	...do	...do	50.0520
Gordon	50	...do	...do	52.3280
Gwinnett	52	...do	...do	47.3600
Habersham	53	...do	...do	50.2240
Hancock	55	...do	White mixed	35.7080
Haralson	56	...do	White	56.1570
Hart	58	...do	White mixed	42.4550
Heard	59	...do	White	43.1120
Henry	60	...do	Mixed	43.2460
Jasper	63	...do	White	41.2540
Johnson	64	...do	...do	38.0280
Jones	65	...do	White mixed	43.3010
Laurens	66	...do	White	31.5020
Liberty	67	...do	Mixed	32.6340
Lincoln	68	...do	White mixed	37.3860
Lowndes	69	...do	...do	28.6160
McDuffie	71	...do	Mixed	34.8120
Macon	72	...do	White mixed	30.3910
Madison	73	...do	White	53.9590
Meriwether	75	...do	...do	46.1660
Montgomery	78	...do	...do	35.3390
Morgan	79	...do	White mixed	38.3160
Muscogee	81	...do	White	41.8700
Newton	82*b*	...do	White mixed	34.9500
Oglethorpe	84	...do	...do	34.1580
Paulding	85	...do	Mixed	46.0610
Pickens	86	...do	White	47.8590
Pierce	87	...do	Mixed	33.0200
Polk	88	...do	White	47.4460
Quitman	90	...do	...do	31.4300
Rabun	91	...do	...do	43.7510
Randolph	92	...do	Yellow	33.5490
Schley	95	...do	White	29.9720
Spalding	96	...do	Yellow	37.3400
Sumter	98	...do	White mixed	49.5240
Talbot	99	Flint	White	41.6920
Tattnall	100	Dent	Yellow	33.9970
Telfair	101	...do	White	30.0920
Terrell	102	...do	White mixed	30.0200
Troup	105	...do	White	42.8540
Union	106	...do	...do	44.9360
Upson	107	...do	...do	32.9920
Walton	108	...do	White mixed	46.9480
Warren	109	...do	White	38.7960
Webster	112	...do	...do	32.1400
White	113	...do	...do	57.1580
Whitfield	114	...do	White and yellow	40.0270
Florida:				
Clay	5	Dent	White	31.2500
Columbia	6	Dent and Flint	Yellow and white	31.1340
Gadsden	8	Dent	White mixed	26.7860
Hernando	10	...do	...do	28.5960
Jackson	12	...do	...do	44.1160
Madison	15	...do	White	43.1560
Manatee	16	...do	Yellow and white	29.6940
Putnam	19	...do	Mixed	38.0460
Taylor	22	...do	White mixed	27.2250
Alabama:				
Bibb	3	Dent	White	32.9560
Blount	4	...do	...do	30.5550
Butler	6	...do	Mixed	27.1580
Cherokee	9	...do	White mixed	40.1277
Chilton	10	...do	White	46.9630
Clarke	12	...do	Yellow	48.6520
Do	12*a*	...do	White mixed	31.9532
Colbert	15	...do	...do	44.5242
Culiman	18	...do	White	35.6457
Dale	19	...do	White mixed	32.4954
Dallas	20	...do	Mixed	37.9880
Escambia	22	...do	...do	30.2945
Etowah	23	...do	White	41.8220
Fayette	24	...do	White mixed	41.3400
Geneva	26	...do	White	21.1625
Greene	27	...do	Mixed	28.7150
Hall	28	...do	White	36.5180

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Alabama—Continued.				*Grams.*
Henry	29	Dent	White	32.2886
Jackson	30	...do	...do	46.0700
Jefferson	31	...do	White mixed	38.8657
Lamar	32	...do	White	37.2571
Lauderdale	33	...do	...do	56.6144
Limestone	36	...do	White mixed	42.8556
Lowndes	37	...do	White	33.8680
Madison	39	...do	White mixed	49.3930
Marengo	40	...do	...do	34.1770
Marion	41	...do	Mixed	41.8520
Morgan	46	Dent and Flint	White	36.3313
Do	46*a*	Dent	White mixed	51.5800
Perry	47	...do	White	40.9950
Pike	49	...do	...do	22.1005
Randolph	50	...do	...do	24.6148
Russell	51	...do	...do	31.5230
Saint Clair	52	...do	White mixed	46.5350
Shelby	53	...do	...do	52.9600
Tallapoosa	56	...do	White	35.5350
Washington	58	...do	Red	38.7158
Mississippi:				
Alcorn	1	Dent	Yellow	48.9840
Calhoun	4	...do	White mixed	35.1310
Carroll	5	...do	White	25.9460
Do	5*a*	...do	...do	48.5970
Choctaw	7	...do	White mixed	44.6050
Claiborne	8	...do	White	32.0940
Clarke	9	...do	Mixed	22.7770
Copiah	10	...do	White mixed	39.5290
Greene	13	...do	White	39.9570
Hinds	16	...do	White mixed	43.2710
Jasper	20	...do	White	28.3290
Jefferson	21	...do	Yellow mixed	34.3140
La Fayette	23	...do	White	55.2550
Lowndes	25	...do	Mixed	27.3950
Marshall	27	...do	White	49.8310
Neshoba	28	...do	Streaked	26.0220
Newton	29	...do	White	33.1620
Rankin	34	...do	...do	31.8600
Scott	35	...do	...do	37.4090
Simpson	37	...do	Streaked	27.2700
Do	37*a*	...do	White mixed	31.5678
Smith	38	...do	White	30.6740
Tate	40	...do	White mixed	39.9880
Tishoningo	42	...do	White	43.6680
Union	43	...do	...do	38.9320
Wayne	44	...do	Mixed	30.0850
Webster	45	...do	White	40.0700
Wilkinson	46	...do	...do	33.3670
Winston	47	...do	...do	26.0300
Louisiana:				
Cameron	7	Dent	Yellow	35.2190
De Soto	11	...do	White	28.5780
East Carroll	12	...do	do	37.1730
Iberville	15	...do	Yellow and white	35.2480
Jackson	16	...do	White	15.5040
Jefferson	29	Flint	Yellow	29.4170
Madison	20	Dent	White	33.8530
Natchitoches	22	...do	...do	39.7050
Pointe Coupée	23	...do	...do	29.5830
Saint Helena	30	...do	Yellow	35.7330
Saint Mary's	32	...do	...do	36.9630
Saint Tammany	33	...do	White mixed	29.6020
Tangipahoa	34	...do	Flesh	26.7330
Michigan:				
Barry	28	Dent	Yellow	20.9080
Bay	29	...do	...do	42.6000
Cass	30	...do	...do	26.2620
Crawford	31	Flint	White	32.0900
Eaton	33	Dent	Yellow	36.4880
Hillsdale	38	...do	...do	25.1650
Macomb	44	Flint	...do	34.2050
Manitou	45	...do	White	42.3580
Missaukee	51	...do	Yellow	23.4840
Do	51*a*	...do	...do	26.8200
Oscoda	55	Dent	Yellow and white	29.7980
Roscommon	75	Flint	Yellow	32.5480
Do	75*a*	...do	...do	32.9020
Saginaw	58	...do	...do	35.6920

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number	Variety.	Color.	Weight.
Michigan—Continued.				*Grams.*
Saint Clair	59	Flint	White	33.2850
Shiawassee	61	Dent	Yellow	27.5560
Tuscola	62	...do	Red	33.1720
Van Buren	63	...do	Yellow	30.4730
Wisconsin:				
Jefferson	30	Dent	Yellow	22.3190
Ohio:				
Adams	1	Dent	White	40.5060
Ashland	6	...do	Yellow	34.2802
Ashtabula	46	...do	...do	34.4770
Carroll	7	...do	...do	29.8493
Champaign	30	...do	...do	32.6658
Columbiana	23	...do	...do	25.3884
Coshocton	37	...do	...do	31.8665
Defiance	25	...do	White	37.4036
Delaware	11	...do	Yellow	22.8365
Erie	3*a*	...do	...do	21.1618
Fairfield	19	...do	Red	27.6386
Fulton	61	...do	Yellow	30.9250
Greene	18	...do	...do	40.4586
Henry	28	...do	...do	25.9740
Hocking	49	...do	...do	26.7752
Holmes	10	...do	...do	43.8076
Huron	90	...do	...do	33.1150
Jefferson	47	...do	...do	31.2440
Lawrence	68	...do	White	36.4650
Licking	17	...do	Red	38.4322
Lorain	69	...do	...do	28.2750
Lucas	12	...do	Yellow	23.4521
Madison	70	...do	...do	32.0610
Do	70*a*	...do	...do	41.5100
Mahoning	71	...do	...do	33.2640
Marion	72	...do	White mixed	35.0260
Medina	45	...do	Yellow	36.9214
Meigs	13	...do	White	38.3315
Do.	13*a*	...do	Red	36.6330
Montgomery	73	...do	Yellow	37.5540
Morrow	33	...do	...do	29.3361
Noble	9	...do	...do	34.6856
Ottawa	35	...do	...do	34.0585
Paulding	16	...do	...do	37.4692
Pike	76	...do	White	40.2480
Portage	48	...do	Yellow	26.6815
Putnam	29	...do	...do	34.6350
Richland	27	...do	...do	32.9336
Ross	15	...do	...do	28.3966
Sandusky	78	...do	...do	31.1770
Seneca	20	...do	...do	34.8586
Shelby	38	...do	White	25.2562
Do	5	...do	Yellow	23.9230
Stark	31	...do	Red	30.2410
Trumbull	81	...do	Yellow	27.3670
Tuscarawas	8	...do	...do	23.2740
Van Wert	83	...do	...do	26.1070
Vinton	21	...do	White	36.6730
Warren	24	...do	Red	40.6228
Williams	89	...do	Yellow	35.6770
Wood	43	...do	...do	32.1916
Wyandot	14	...do	...do	32.6129
Indiana:				
Adams	59	Dent	Yellow	28.1696
Benton	18	...do	Yellow and white	22.6528
Blackford	69	...do	Yellow	35.3738
Boone	47	...do	...do	35.2074
Carroll	24	...do	...do	42.5918
Clark	70	...do	Streaked	34.9800
Clay	40	...do	White	29.2262
Crawford	10	...do	...do	22.0645
Dearborn	9	...do	Yellow	50.5868
De Kalb	60	...do	...do	13.8586
Elkhart	73	...do	...do	28.8760
Fayette	56	...do	...do	31.5564
Fountain	11	...do	...do	31.2786
Franklin	74	...do	...do	35.4210
Fulton	75	...do	White	31.3630
Harrison	52	...do	Yellow	45.7316
Henry	55	...do	...do	37.4432
Howard	2	...do	Red	39.9674
Huntington	12	...do	Yellow and white	30.7252

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Indiana—Continued.				*Grams.*
Jackson	15	Dent	White	47.7678
Jasper	8	do	Yellow	21.4614
Jay	50	do	do	29.4946
Kosciusko	36	do	White	24.4790
La Grange	38	do	Yellow	27.0386
La Porte	62	do	do	37.9586
Marshall	33	do	do	29.9606
Monroe	49	do	White	37.0898
Montgomery	45	do	Yellow	33.2980
Morgan	1	do	do	51.2106
Noble	22	do	do	31.3866
Ohio	84	do	White	44.9470
Orange	85	do	Yellow	43.3770
Do	85*a*	do	White	35.9280
Parke	87	do	Yellow	34.8950
Porter	46*a*	do	White	34.0074
Pulaski	5	do	Yellow	32.3495
Putnam	48	do	do	30.1016
Ripley	90	do	White	33.7740
Do	90*a*	do	do	31.2960
Rush	44	do	Yellow	36.3008
Shelby	4	do	White	41.9728
Starke	3	do	Yellow	30.5522
Steuben	13	do	White	22.4916
Do	13*a*	do	Yellow	35.4294
Sullivan	43	do	do	32.4928
Switzerland	94	do	White	52.1730
Do	94*a*	do	do	38.4600
Tipton	96	do	Yellow	43.4290
Union	97	do	do	32.9960
Vermillion	19	do	White	40.4894
Wabash	21	do	Yellow and white	35.5470
Wells	5	do	do	19.9096
White	17	do	Yellow	31.0168
Whitley	100	do	do	36.8400
Do	100*a*	do	White	35.2810
Illinois:				
Adams	67	Dent	White	46.3570
Alexander	94	do	do	30.1240
Bond	68	do	do	32.9010
Bureau	95	do	Yellow	35.7732
Champaign	42	do	do	23.3640
Christian	44	do	Red	41.5586
Clay	14	do	Yellow	32.2042
Cook	59	do	do	31.4356
Cumberland	71	do	White	37.5070
De Kalb	8	do	Yellow	28.6136
De Witt	72	do	do	31.1960
Douglass	34	do	White	41.3564
Edgar	49	do	do	41.0110
Effingham	57	do	Yellow	34.2900
Fayette	3	do	White	39.0250
Ford	25	do	do	29.9876
Fulton	57	do	do	31.0780
Gallatin	7	do	do	38.5586
Hancock	50	do	Yellow	36.7812
Jackson	76	do	White	44.7320
Jasper	40	do	Yellow	30.7186
Jefferson	56	do	Red	36.0186
Jersey	15	do	do	30.3520
Jo. Daviess	22*a*	do	Yellow	24.6400
Kankakee	79	do	White	31.5150
Kendall	51	do	Yellow	27.4037
Lake	30	do	do	25.0166
La Salle	41	do	White	42.6040
Lee	21	do	Yellow	33.4286
Livingston	23	do	do	33.7684
McDonough	13	do	do	39.1186
McHenry	20	do	do	32.6980
Do	20*a*	do	White	35.7840
McLean	6	do	Yellow	30.1254
Macon	48	do	do	33.7386
Marshall	52	do	do	26.5058
Mercer	10*a*	do	White	27.8624
Do	11	do	Yellow	40.2412
Monroe	29	do	White	42.4926
Montgomery	55	do	Yellow	42.6406
Ogle	43	do	do	31.1986
Do	43*a*	do	White	30.2512
Peoria	83	do	Yellow	27.7110

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Illinois—continued.				*Grams.*
Perry	17	Dent	Yellow	29.9728
Pike	84	...do	...do	41.3440
Pulaski	86	...do	White	22.6770
Rock Island	36	...do	Yellow	31.5156
Sangamon	88	...do	White	46.8000
Schuyler	89	...do	Yellow	40.2030
Scott	100	...do	White	46.0830
Stephenson	18	...do	Red	25.3242
Tazewell	101	...do	White	31.6850
Union	102	...do	White mixed	39.2440
Vermillion	1	...do	Yellow	29.3676
Wabash	45	...do	White	33.1156
Warren	75	...do	Yellow	31.7960
Do	46	...do	...do	33.0220
Will	19	...do	...do	36.3090
Williamson	24	...do	White	46.2586
Minnesota:				
Benton	31	Dent	Yellow	21.1542
Big Stone	13	...do	...do	39.8516
Do	42	Flint	White, yellow, and black	31.3684
Brown	25	Dent	White	22.0909
Carver	35	...do	...do	25.8165
Do	38	...do	Yellow	24.1843
Dakota	16	...do	White	24.1786
Douglas	7	Flint	Yellow	41.2822
Fillmore	17	Dent	Red	32.0554
Houston	10	...do	Yellow	29.2991
Isanti	19	...do	...do	19.4474
Jackson	4	...do	Red	19.9821
Kandiyohi	24	...do	Yellow	19.2792
Lac-qui-parle	10	...do	...do	19.4693
Martin	30	...do	...do	26.4604
Do	29	...do	White	24.2838
Meeker	28	...do	Yellow	24.1566
Morrison	43	...do	...do	16.2254
Nicollet	12	...do	...do	26.5099
Nobles	32	...do	...do	20.7930
Olmsted	33	...do	...do	17.7810
Otter Tail	22	Flint	...do	25.7456
Pipe Stone	26	Dent	White, yellow, and red	24.9243
Pope	36	Flint	Yellow	33.0280
Rice	41	Dent	...do	18.3767
Scott	39	...do	...do	26.7942
Do	39*a*	...do	White	29.7727
Do	40	Flint	Yellow	35.6121
Sibley	5	Dent	...do	26.2399
Wadena	49	...do	Mixed	17.6820
Washington	44	...do	Yellow	25.4284
Watonwan	20	...do	...do	16.0737
Wilkin	3	Flint	Red	26.7068
Winona	6	Dent	White	27.8001
Dakota:				
Beadle	30	Dent	Yellow	27.8736
Bon Homme	12	...do	...do	33.5224
Do	43	...do	...do	32.1690
Charles Mix	5	...do	Red	37.2568
Clay	21	...do	White	26.3893
Do	32	...do	Yellow	28.5002
Do	10	...do	...do	24.2168
Davison	9	...do	White	28.9386
Hughes	36	...do	Yellow	25.3156
Hutchinson	25	...do	Red	26.5986
Do	17	...do	Yellow	22.7064
Jerauld	31	...do	Red	19.3602
Lincoln	23	...do	Yellow	18.5560
Do	18	...do	White	24.7318
Do	11	...do	Red	19.7472
McCook	4	...do	Yellow	33.4468
Minnehaha	24	...do	...do	23.4876
Moody	7	...do	...do	18.5598
Do	8	...do	...do	25.5314
Morton	14	Flint	White and black	32.1986
Spink	29	Dent	Red	21.5493
Do	16	...do	Yellow	23.3092
Stutsman	35	Flint	White	30.6346
Union	7	Dent	Yellow	28.0728
Yankton	27	...do	White	30.6512
Do	20	...do	Yellow	27.5498

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Montana:				
Custer				*Grams.*
Dawson	1	Flint	Yellow	26.5140
Yellowstone				
Iowa:				
Allamakee	3	Dent	Striped	38.6840
Audubon	5	...do	White	32.8640
Benton	6	...do	...do	35.6600
Black Hawk	7	...do	Yellow	40.2990
Buchanan	9	...do	...do	22.9360
Buena Vista	10	...do	...do	26.8740
Calhoun	12	...do	...do	23.4840
Cerro Gordo	15	...do	White	25.5670
Cherokee	16	...do	Yellow	26.4880
Chickasaw	17	...do	White	31.4780
Clay	19	...do	Yellow	30.3280
Clinton	21	...do	...do	24.1820
Crawford	22	...do	...do	27.6350
Dallas	23	...do	...do	34.6070
Davies	24	...do	...do	34.3350
Decatur	25	...do	White	31.7660
Delaware	26	...do	Mixed	35.3040
Dickinson	28	...do	Yellow	28.9840
Floyd	32	...do	White mixed	25.4180
Greene	35	...do	Striped	34.8658
Guthrie	36	...do	Streaked	36.4130
Hamilton	37	...do	Yellow	37.4300
Henry	40	...do	...do	29.4160
Humboldt	42	...do	White mixed	28.7750
Ida	43	...do	Yellow	31.3590
Iowa	44	...do	...do	28.1080
Jasper	46	...do	...do	33.5990
Jones	49	...do	White	30.0030
Keokuk	50	...do	Yellow	43.2980
Lee	52	...do	...do	34.4640
Louisa	54	...do	...do	41.8990
Lucas	55	...do	...do	29.2090
Mahaska	58	...do	...do	29.1820
Marion	59	...do	...do	45.3770
Mills	61	...do	...do	23.6140
Muscatine	65	...do	...do	35.8070
Poweshiek	73	...do	...do	37.7270
Sac	75	...do	Mixed	31.3899
Sioux	56	...do	Yellow	26.6380
Story	78	...do	...do	35.1920
Tama	79	...do	...do	29.8040
Van Buren	82	...do	White	42.0150
Warren	83	...do	Yellow	29.1020
Washington	84	...do	...do	32.5490
Winneshiek	87	...do	...do	23.4050
Worth	89	...do	...do	26.3120
Wright	90	...do	...do	24.4650
Nebraska:				
Adams	17	Dent	Red and yellow	27.8096
Boone	33	...do	Yellow	34.2560
Buffalo	20	...do	...do	31.3840
Do	21	...do	...do	43.6348
Do	24	...do	...do	40.3420
Burt	15	...do	...do	24.9534
Butler	53	...do	...do	36.5940
Cass	3	...do	Red and yellow	30.9986
Colfax	2	...do	Yellow and white	27.0632
Cuming	22	...do	Red, yellow, & white	27.2164
Custer	18	...do	Yellow	29.3760
Dakota	34	...do	...do	28.9710
Dawson	35	...do	...do	33.4270
Dixon	56	...do	...do	31.8700
Dodge	16	...do	...do	22.1462
Franklin	58	...do	Yellow and white	41.3900
Frontier	59	...do	Yellow	37.7530
Furnas	23	...do	...do	33.9092
Gosper	38	...do	...do	37.0230
Greeley	12	...do	...do	24.3986
Hitchcock	61	...do	Yellow and white	25.2220
Holt	40	...do	Yellow	27.8020
Howard	1	...do	White	42.3510
Johnson	6	...do	Yellow	33.6380
Do	10	...do	...do	30.7426
Kearney	25	...do	White	32.2800
Do	25a	...do	Striped	33.8632

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Nebraska—Continued.				*Grams.*
Merrick	14	Dent	Yellow	31.4826
Nance	64	...do	...do	41.4650
Nemaha	4	...do	Red	47.2490
Do	4*a*	...do	Yellow	44.0820
Do	4*b*	...do	...do	37.0976
Do	4*c*	...do	White	45.1110
Pawnee	46	...do	Yellow	32.5960
Platte	48*a*	...do	...do	26.1400
Richardson	49	...do	...do	33.7360
Sarpy	5	...do	...do	30.8670
Saunders	51	...do	...do	30.1700
Sherman	67	...do	White	37.7540
Washington	19	...do	Yellow	32.8314
Do	13*a*	...do	...do	34.0010
Webster	52	...do	...do	33.3990
Missouri:				
Atchison	2	Dent	Yellow	46.4220
Do	3	...do	...do	45.9750
Barry	4	...do	White	50.1380
Barton	5	...do	White mixed	35.4430
Bollinger	7	...do	White	44.7870
Do	7*a*	...do	Yellow	40.2990
Caldwell	10	...do	...do	40.3230
Carter	15	...do	White	45.6560
Cedar	90	...do	Red	40.5160
Christian	16	...do	White	44.0020
Dallas	22	...do	...do	36.1920
De Kalb	94	...do	Yellow	47.7470
Dent	24	...do	...do	38.7070
Dunklin	26	...do	Red	39.8890
Gasconade	28	...do	White	34.4340
Harrison	31	...do	Yellow	50.4940
Henry	96	...do	...do	43.2170
Hickory	32	...do	...do	31.5960
Iron	98	...do	White	37.8310
Johnson	37	...do	...do	54.0360
Do	37*a*	...do	Yellow	53.0390
Knox	38	...do	Red	40.8630
Laclede	39	...do	...do	56.5390
Macon	47	...do	White	55.9110
Madison	48	...do	Yellow	37.2830
Maries	100	...do	White	38.3780
Marion	101	...do	Yellow	33.2060
Miller	50	...do	...do	38.5970
Moniteau	51	...do	White	37.3670
Monroe	52	...do	...do	39.6940
Montgomery	103	...do	Yellow	45.5300
Morgan	53	...do	...do	43.1300
New Madrid	54	...do	White	26.9860
Nodaway	56	...do	Yellow	28.6320
Osage	57	...do	...do	43.6740
Ozark	58	...do	...do	57.6890
Pike	61	...do	...do	33.5950
Platte	62	...do	White	46.8910
Do	62*a*	...do	Streaked	40.6350
Pulaski	64	...do	Yellow	46.3600
Do	64*a*	...do	White	50.7280
Ralls	66	...do	Streaked	58.7740
Ripley	68	...do	White mixed	37.1610
Saint Francis	71	...do	Yellow	39.5320
Saint Genevieve	72	...do	Streaked	27.4880
Saint Louis	73	...do	Yellow	38.3670
Do	73*a*	...do	White	38.8740
Schuyler	74	...do	Yellow	31.0690
Scott	76	...do	White	38.2430
Shelby	77	...do	Red	35.1860
Stoddard	78	...do	White	42.3290
Stone	79	...do	...do	36.7240
Taney	80	...do	...do	52.8770
Vernon	81	...do	...do	46.2650
Warren	82	...do	...do	31.5960
Wayne	84	...do	...do	37.1600
Do	84*a*	...do	...do	34.6300
Worth	85	...do	...do	26.3210
Arkansas:				
Arkansas	1	Dent	Mixed	46.6680
Baxter	2	...do	Yellow	41.8600
Bradley	3	...do	White mixed	44.3240
Carroll	5	...do	White	33.2310

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Arkansas—Continued.				*Grams.*
Columbia	9	Dent	Mixed	37.0570
Craighead	11	...do	White	43.4640
Crawford	12	...do	White mixed	36.4120
Crittenden	13	...do	...do	38.5940
Dallas	15	...do	White	37.6780
Dorsey	16	...do	...do	40.6680
Drew	17	...do	...do	35.9580
Franklin	18	...do	...do	41.2990
Fulton	19	...do	White mixed	49.9080
Grant	21	...do	Yellow	33.8740
Hempstead	22	...do	White mixed	39.5840
Do	22*a*	...do	Red	43.7830
Howard	23	...do	White mixed	35.5280
Independence	24	...do	...do	43.4040
Izard	25	...do	Flesh	39.1470
Jackson	26	...do	White	46.4070
Jefferson	27	...do	White mixed	35.9630
La Fayette	29	...do	White	38.4100
Lincoln	31	...do	Yellow	49.8740
Do	31*a*	...do	White mixed	43.7840
Marion	35	...do	White	47.7520
Mississippi	36	...do	...do	34.0920
Montgomery	37	...do	Flesh	42.5310
Nevada	38	...do	White	40.4280
Perry	40	...do	...do	44.0520
Phillips	41	...do	...do	34.1700
Do	42	...do	...do	43.4960
Searcy	49	...do	...do	46.0190
Sharp	52	...do	White mixed	44.1390
Stone	53	...do	White	55.5810
Yell	57	...do	...do	34.9030
Kansas:				
Allen	1	Dent	Yellow	45.9640
Barton	5	...do	White	32.5590
Bourbon	6	...do	Yellow	40.4200
Brown	7	...do	White	35.8580
Chautauqua	9	...do	Streaked	43.7080
Cherokee	10	...do	White	39.8440
Do	10*a*	...do	Yellow	39.4520
Clay	11	...do	...do	29.4040
Coffey	13	...do	White mixed	36.6340
Do	13*a*	...do	Yellow	40.4570
Crawford	15	...do	White	33.6288
Decatur	17	Flint	Yellow	28.3320
Dickinson	18	Dent	Streaked	42.3760
Do	18*a*	...do	Yellow	39.2370
Douglas	19	...do	White	39.6220
Ellsworth	23	...do	...do	50.8150
Ford	25	...do	Red	34.1490
Greenwood	28	...do	Yellow	35.8090
Harper	29	...do	White	37.9610
Harvey	30	...do	Yellow	41.4880
Hodgeman	31	...do	White	24.2170
Jewell	70	...do	Streaked	39.1190
Do	70*a*	...do	Yellow	38.8740
Kingman	37	...do	White	42.6530
Do	37*a*	...do	Yellow	46.5290
Labette	38	...do	...do	44.5380
Leavenworth	40	...do	...do	38.7040
Lincoln	41	...do	Red	50.0360
Do	41*a*	...do	Yellow	39.4130
Linn	42	...do	Striped	45.0980
Lyon	43	...do	Yellow	55.1700
Marshall	46	...do	...do	42.3340
Nemaha	50	...do	...do	31.5770
Neosho	51	...do	...do	33.8760
Norton	53	...do	White mixed	47.7980
Osborne	55	...do	Yellow	36.0960
Pawnee	57	...do	White	37.5650
Pottawatomie	59	...do	Yellow	40.0630
Rawlins	60	...do	...do	29.5060
Reno	61	...do	White	38.3770
Do	61*a*	...do	Yellow	39.3440
Republic	62	...do	...do	48.2930
Shawnee	69	...do	...do	34.4940
Sumner	73	...do	Red	51.1690
Wabaunsee	74	...do	Yellow	31.4350
Indian Territory:				
Chickasaw	2	Dent	Red	42.0630
Do	2*a*	...do	Yellow	32.8680

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
Indian Territory—Continued.				*Grams.*
Choctaw	3	Dent	White	48.2520
Tahlequa	5	...do	White mixed	43.2790
Texas:				
Anderson	1	Dent	White	40.8520
Angelina	2	...do	Yellow mixed	30.2600
Aransas	3	...do	White	32.4440
Austin	4	...do	...do	24.0650
Bandera	5	...do	...do	36.4350
Bowie	10	...do	Yellow mixed	48.1970
Brown	13	...do	Yellow and red	37.6200
Burleson	14	...do	White	44.9240
Callahan	16	...do	...do	36.6350
Cass	18	...do	...do	51.4440
Cherokee	20	...do	Mixed	40.0240
Collins	23	...do	Yellow	35.2530
Colorado	24	...do	White	37.6940
Comanche	25	...do	Yellow streaked	46.0680
Denton	30	...do	Yellow	36.8720
Do	30*a*	...do	White	45.7720
De Witt	31	...do	...do	39.0130
Eastland	33	...do	Yellow	43.8620
El Paso	35	Flint	Mixed	29.3970
Falls	37	Dent	White mixed	32.6080
Fannin	38	...do	Yellow	43.1930
Do	38*a*	...do	White	39.8540
Fort Bend	40	...do	White mixed	33.3710
Goliad	43	...do	Yellow	38.8770
Grayson	45	...do	White mixed	43.3590
Gregg	46	...do	White	46.2790
Guadalupe	48	...do	Mixed	37.0450
Hardeman	49	...do	Yellow	36.8040
Harrison	51	...do	White mixed	36.0880
Hunt	55	...do	White	57.2310
Jack	56	...do	Streaked	40.6730
Jackson	57	...do	White	27.8950
Karnes	61	...do	Yellow	28.1680
Kaufman	62	...do	Mixed	31.9880
Kendall	63	...do	White mixed	42.6770
Kerr	64	...do	Yellow	29.4230
Kinney	66	...do	White	36.8330
Lampasas	67	...do	White mixed	35.3770
Lavaca	68	...do	...do	29.9830
Lee	69	...do	White	34.9560
Leon	70	...do	White mixed	44.4950
Matagorda	76	...do	White	37.8030
Medina	77	...do	...do	41.1280
Menard	78	...do	...do	26.6530
Nueces	83	...do	Yellow mixed	30.6020
Panola	85	...do	White	34.4860
Parker	86	...do	Red	42.8480
Polk	87	...do	Mixed	36.5840
Rusk	93	...do	White	37.9830
San Saba	96	...do	do	40.9840
Shelby	98	...do	Mixed	22.2990
Somerville	99	...do	Yellow	34.1640
Stephens	100	...do	White, yel., and red	37.6700
Tarrant	101	...do	Yellow	31.4250
Throckmorton	103	...do	Striped	37.4260
Titus	104	...do	White	43.7220
Tom Green	105	...do	Mixed	29.8190
Victoria	112	...do	White mixed	32.6740
Waller	114	...do	...do	38.8550
Washington	115	...do	White	41.8480
Webb	116	Dent and Flint	...do	41.2140
Williamson	117	Dent	Flesh	40.1180
Wise	118	...do	Yellow	41.5630
Colorado:				
Custer	14	Dent	Yellow	29.9280
Douglas	4	...do	White	16.8545
Fremont	15	Flint	...do	41.1520
Gunnison	7	Dent	Yellow	19.4905
Jefferson	....	...do	...do	30.8917
Larimer	....	...do	...do	28.1615
Las Animas	16	...do	Yellow mixed	39.1460
Pueblo	10	...do	Yellow and white	33.8632
Utah:				
Box Elder	1	Dent	Yellow	34.4580
Millard	7	Flint	Mixed	27.7030
Morgan	8	...do	...do	25.7850

CORN, WEIGHT OF 100 KERNELS—CONTINUED.

State and county.	Serial number.	Variety.	Color.	Weight.
				Grams.
Utah—Continued.				
Salt Lake	10	Dent	Yellow	37.5040
Sevier	11	....do	....do	17.8290
Washington	14	Flint	White	36.2430
Weber	15	....do	Yellow	46.9960
New Mexico:				
Colfax	1	Flint	White	35.0450
Doña Aña	2	Dent and Flint	Mixed	33.4360
Grant	3	Dent	White	35.1530
Santa Fé	7	Flint	Black	32.7900
Washington Territory:				
Assotin	6	Dent	White	28.0380
Garfield	7	Flint	Yellow	44.4785
Whatcom	18	....do	Reddish yellow	43.8130
Oregon:				
Columbia	5	Dent	Yellow	30.1540
Coos	6	Flint	....do	24.9590
Lane	10	Dent	Mixed	36.6620
Linn	11	Flint	Yellow	35.7600
Marion	12	Dent	White mixed	43.3380
Yam Hill	17	....do	White	31.7390
Nevada:				
Esmeralda	4	Flint	Yellow	27.1390
California:				
Amador	4	Dent	Yellow	28.1960
Calaveras	13	Flint	....do	33.2986
Contra Costa	7	Dent	White	29.9986
Do	18	....do	Yellow	42.7586
Mendocino	27	....do	White	33.2530
Napa	28	....do	Yellow	21.6030
Placer	30	....do	....do	36.8930
San Benito	3	....do	Yellow and white	31.3476
San Bernardino	8	....do	White	41.0386
San Diego	15	....do	....do	49.1130
San Joaquin	9	Flint	....do	24.5209
Santa Cruz	5	Dent	Yellow	39.0850
Shasta	11	....do	....do	28.9954
Stanislaus	12	....do	White	41.5910
Tuolumne	16	....do	....do	31.0046
Yuba	34	....do	Yellow	25.4550

The weight of nearly eleven hundred specimens have been taken and the results divided as Dent, Flint, and Flint-Dent.

Averages from the results have been calculated for the whole country, different sections, and each State.

CORN, AVERAGE WEIGHT OF 100 KERNELS.

Dent.

Locality.	No. of samples.	Average.	Highest.	Lowest.
		Grams.	*Grams.*	*Grams.*
United States	1,009	36.7475	64.1020	13.8586
Middle States	34	30.6963	58.1560	27.4900
Southern States	427	40.8233	64.1020	15.5040
Northern Central States	177	33.5430	51.2106	13.8586
Northwestern States	140	29.1013	47.2490	16.0737
Southwestern States	202	39.8208	57.6890	22.2990
Mountain region	10	32.3279	39.1460	16.8545
Pacific States	18	34.7727	49.1130	21.6030
New York	2	31.0393	33.3200	28.7586
Pennsylvania	12	34.9457	41.3560	27.4900
New Jersey	5	44.2956	56.6640	35.7330
Maryland	15	42.7112	58.1560	34.0010
Virginia	54	43.2024	59.7100	24.1600
West Virginia	27	39.2584	50.8610	26.7720
Kentucky	54	42.4498	60.9090	28.0280
Tennessee	60	45.2508	64.1020	29.6330
North Carolina	58	42.6440	60.6360	30.1470
South Carolina	17	37.3088	54.6680	27.1930
Georgia	72	39.6891	63.1250	25.1970
Florida	8	33.6086	44.1160	26.7860
Alabama	36	37.9630	56.6144	21.1625

CORN, AVERAGE WEIGHT OF 100 KERNELS—CONTINUED.

Dent—Continued.

Locality.	No. of samples.	Average.	Highest.	Lowest.
		Grams.	*Grams.*	*Grams.*
Mississippi	29	36. 0731	55. 2550	22. 7770
Louisiana	12	31. 9912	39. 7050	15. 5040
Michigan	10	31. 4784	42. 6000	20. 9080
Wisconsin	1	22. 3190	......	....
Ohio	52	32. 4428	43. 8076	21. 1618
Indiana	55	34. 2614	51. 2106	13. 8586
Illinois	59	34. 3831	46. 8000	22. 6770
Minnesota	27	24. 0159	39. 8516	16. 0737
Dakota	24	26. 1268	37. 2568	18. 5560
Iowa	47	31. 7087	45. 3770	22 9360
Nebraska	42	33. 5332	47. 2490	22. 1462
Missouri	58	40. 9470	57. 6890	26. 3210
Arkansas	35	41 3725	55. 5810	33 2310
Kansas	44	39 8887	55. 1700	24. 2170
Indian Territory	4	41. 6155	48. 2520	32. 8680
Texas	61	37. 6929	57. 2310	22. 2990
Colorado	7	28. 3336	39. 1460	16. 8545
Utah	3	29. 9303	37. 5040	17. 8290
New Mexico	1	35. 1530	....	....
Washington Territory	1	28. 0380	....	....
Oregon	4	35. 4732	43. 3380	30. 1540
California	13	34. 9905	49. 1130	21. 6030

Flint.

Locality.	No. of samples.	Average.	Highest.	Lowest.
United States	81	32. 6254	54. 4970	17. 6820
New England States	15	32. 0839	51. 7450	17. 7670
Middle States	29	32. 9688	54. 4970	18. 6986
Southern States	5	33. 5484	41. 6220	25. 4800
Northern Central States	6	30. 9293	35. 6920	26. 8200
Northwestern States	10	30. 1772	41. 2822	17. 6820
Southwestern States	2	28. 8645	29. 3970	28. 3320
Mountain region	7	35. 0963	46. 9960	25. 7850
Pacific States	8	33. 6780	44. 4785	24. 5209
Maine	6	30. 4801	41. 7080	21. 3015
New Hampshire	1	17. 7670	......	....
Vermont	2	28 4020	30. 1690	26. 6350
Massachusetts	5	39. 2321	51. 7450	28. 7824
Connecticut	1	37. 6470	....	....
New York	22	30. 2896	43. 1110	18. 6986
Pennsylvania	3	38. 4430	43. 7330	35. 6170
New Jersey	2	41. 9360	46. 2980	37. 5740
Maryland	2	45. 2660	54. 4970	36. 0350
Kentucky	1	39. 7160	....	....
South Carolina	1	31. 5070	....	....
Georgia	2	33. 5510	41. 6220	25. 4800
Louisiana	1	29. 4170	....	....
Michigan	6	30. 9293	35. 6920	26. 8200
Minnesota	7	30. 2036	41. 2822	17. 6820
Dakota	2	31. 4166	32. 1986	30 6346
Montana	1	26. 5140	....	....
Kansas	1	28. 3320	....	....
Texas	1	29. 3970	....	....
Colorado	1	41. 1520	....	....
Utah	4	34. 1817	46. 9960	25. 7850
New Mexico	2	33. 8975	35. 0450	32. 7500
Washington Territory	2	44. 1457	44. 4785	43. 8130
Oregon	2	30. 3595	35. 7600	24. 9590
Nevada	1	27. 1390	....	....
California	3	31. 0915	33. 2986	24. 5209

Dent and flint.

Locality.	No. of samples.	Average.	Highest.	Lowest.
United States	7	34. 8330	41. 2140	28. 0200
Southern States	5	33. 8363	40. 4520	28. 0200
Southwestern States	1	41. 2140	....	....
Mountain region	1	33. 4360	....	....
Virginia	2	34. 2360	40. 4520	28. 0200
North Carolina	1	33. 2440	....	....
Florida	1	31. 1340	....	....
Alabama	1	36. 3313	....	....
Texas	1	41. 2140	....	....
New Mexico	1	33. 4360	....	....

As regards variety, the Dent, as would be expected, averages heavier per hundred kernels than the Flint, and with it also lie the extremes of weight, sixty-four grams per hundred and thirteen. In southern latitudes the Dent kernels are much heavier than in the northern, between the Middle States and the Southern there being a difference of ten grams per hundred. In New England Dent corn is hardly ever raised, but the Flint which is raised nearly equals in weight the Dent of Pennsylvania. Conversely, Flint is only raised in the North and Northwest, and there excels in weight.

The heaviest corn comes from Virginia, North Carolina, Kentucky, and Tennessee, and from the last-named State the heaviest single specimen. The weight per hundred kernels in the larger corn-producing States averages about thirty-two grams (or an ounce), Missouri being somewhat higher—forty grams.

Further study of the table will readily show those interested other peculiarities which it is unnecessary to comment upon at length.

CONCLUSION.

In ending this report it is merely necessary to call attention to sources of error in work of the kind just described. The chief one is from analyses of samples which misrepresent the locality or substance for which they are taken. It is difficult always to avoid such errors, but it is hoped that no mistakes of this sort have crept into the present bulletin. The methods of analyses were such as have been described in previous reports, and all results in doubtful instances have been confirmed by duplicate.

My assistants have been Mr. Edgar Richards, Mr. A. E. Knorr, Mr. Miles Fuller, and Dr. William Frear, and to them is due the credit for a large portion of the analytical work. The baking experiments have been carefully carried on by Mr. John Dugan, while my personal supervision has extended in all directions.

In another bulletin the results of further investigation of the cereals will be reported upon.

APPENDIX.

ON THE COMPOSITION OF THE ASH OF THE WHEAT GRAIN AND WHEAT STRAW GROWN AT ROTHAMSTED IN DIFFERENT SEASONS AND BY DIFFERENT MANURES BY SIR J. B. LAWES AND J. H. GILBERT.

Under this title Lawes and Gilbert have recently published the results of a study of the constituents of wheat which are derived from the soil and of the conditions modifying their assimilation. It has seemed desirable to present their conclusions here as an appendix to the preceding report, and to remark upon their relations to the American plant. The following is therefore given in their own words:*

SUMMARY AND CONCLUSIONS.

The investigation comprises the analyses of 92 wheat-grain and 92 wheat-straw ashes, and, including 69 duplicates, the number of complete ash analyses involved is 253. Every ash is of produce of known history of growth as to soil, season, and manuring, all the specimens having been grown in the experimental field at Rothamsted, which has now yielded wheat for forty years in succession, 1844 to 1883, inclusive. The results are arranged in three series.

FIRST SERIES OF ANALYSES.

1. This series includes results obtained under three very characteristically different conditions as to manuring in each case for sixteen consecutive seasons. The manuring conditions were: Plot 2, farm-yard manure every year; that is, with an excessive supply both of nitrogen and of mineral or ash constituents. Plot 3, without manure every year; that is, with exhaustion of both nitrogen and ash constituents. Plot 10*a*, with ammonium salts alone every year; that is, with an excess of supplied nitrogen, but with great relative deficiency of ash constituents. The results thus illustrate the influence of fluctuations of season from year to year, under known but very different conditions as to manuring.

2. There was a much greater range of variation in the percentages of potash and phosphoric acid in the ashes both of grain and straw, due to variations of season than to variation of manure. The range of variation due to season was much the greater in the straw ashes, which is explained by the fact that favorable or unfavorable seed forming and ripening may supervene on conditions of high or of low luxuriance,

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* Journal of the Chemical Society, Vol. XLV, August, 1884.

that is, of great or of limited activity of accumulation of constituents by the plants; hence the withdrawal of constituents for seed-formation will leave very various amounts of migratory matters in the straw.

3. Taking high weight per bushel of the grain as a fairly good indication of high quality, and *vice versa*, there was with each condition of manuring a general and marked but not uniform tendency to low proportions of nitrogen, of total mineral constituents (ash), and of individual ash constituents, in the dry substance of the grain of the seasons of higher quality; that is, the higher quality of the grain is associated with the greater accumulation of the non-nitrogenous matters (carbohydrates) in proportion to the nitrogen and to the mineral constituents which have been stored up.

4. *Per* 1,000 *dry substance of the grain* there is with each condition as to manuring much greater uniformity in the amount, and a rather lower average amount of potash in the eight better than in the eight worse seasons. Yet it is in a very unfavorable season that there was actually the lowest, and in the worst season of the sixteen that there was actually the highest proportion of potash in the dry substance of the grain; that is, the very different results are obtained under defective but very different conditions of development and maturation.

5. *Per* 1,000 *dry substance of the grain* there is under each of the three conditions as to manuring a lower average amount of phosphoric acid over the eight better seasons, and it is lower in individual seasons of high quality, still there is a wider range than among the eight inferior seasons and wider than in the case of the potash. In the case of the farm-yard manure-plot the lower proportion of phosphoric acid in the better seasons cannot be due to exhaustion, but to enhanced production of organic substance. The average proportion of phosphoric acid to organic substance is, however, lower without manure than with farm-yard manure, and lower still with ammonium salts alone, in which case there is very abnormal mineral exhaustion.

6. The details illustrate in a striking manner the greater influence of season than of manuring on the proportion of the ash constituents to the organic substance of the grain. With normal maturation it is, under otherwise comparable conditions, nearly uniform with different conditions as to manuring; and deviations from normal mineral composition are associated with deviations from normal development of the organic substance.

7. The percentage of silica in the dry substance of the straw is lower in the seasons of more favorable maturation. In fact, stiffness of straw depends on favorable development of the woody substance, by the increase of which the proportion of the accumulated silica to the organic substance is reduced.

8. Excluding the ferric oxide and the silica, and calculating the whole of the phosphoric acid, as tribasic, the grain ashes show more than one and a half times as much acid as base; and even calculating

the whole of the phosphoric acid, whether combined with alkalis or earths as bibasic, there is still an excess of acid. The straw ashes, calculated in the same way, show a considerable excess of base, even reckoning the whole of the phosphoric acid as tribasic; but they contain more than 60 per cent. of silica. The question arises whether carbonic acid (if any) and some sulphuric acid and chlorine have not been expelled in the incineration in the case of the grain-ashes in the presence of acid-phosphates, and in that of the straw ashes in the presence of an excess of silica.

9. Investigations at Rothamsted and elsewhere have established that there is a general increase in the percentage of nitrogen proceeding from the finer to the coarser flours obtained from the same wheat-grain, and that there is marked increase in the more branny portions, the greatest concentration being immediately below the pericarp. The percentage of potash, lime, magnesia, and phosphoric acid also increases from the finer to the coarser flours, and it is the highest in the branny products. The percentage of potash is about ten times, of lime four or five times, of magnesia fifteen to twenty times, and of phosphoric acid more than ten times as high in the dry substance of the bran as in that of the finer flour. It is also established that, in comparable cases, the better matured grains contain the lower percentages of nitrogen and total mineral matter, and a higher percentage of starch; and the ash analyses now under consideration consistently show a lower proportion of the chief individual mineral constituents in the grains of better quality.

10. The average annual amounts of total mineral constituents in the crops *per acre* (grain and straw) over the sixteen years were—with farm-yard manure 237.4 pounds, without manure 106.1 pounds, and with ammonium-salts alone 142 pounds; that is, with ammonium-salts one and a third times, and with farm-yard manure more than twice as much as without manure. With ammonium-salts the greatest proportional increase was in lime, potash, magnesia, soda, sulphuric acid, and chlorine, and the least in phosphoric acid. With farm-yard manure, by far the greatest increase was in potash, of which there is more than two and a half times as much as without manure; and there is about twice as much magnesia, and more than twice as much lime, phosphoric acid, sulphuric acid, soda, and silica, and nearly four times as much chlorine.

11. Comparing the amounts of the individual ash constituents *in the crops per acre* over the first eight years with those over the second eight, they are, without manure, in the grain nearly identical, but in the straw there is more or less deficiency of every constituent, excepting lime, over the second period. Deficiency in the straw and total produce, generally but not uniformly, indicates deficient source. With farm-yard manure there was more of every ash-constituent (excepting sulphuric acid) in the grain, straw, and total produce, over the second period; the most marked increase being, in the grain in potash and phosphoric acid, and

in the straw in potash and silica. With ammonium-salts alone there was, over the second period, in the grain slight deficiency of potash and magnesia, and greater in phosphoric acid, but there was slight increase in lime and sulphuric acid. In the straw there was more marked deficiency in every constituent, excepting sulphuric acid, and the deficiency is the most marked in potash, phosphoric acid, chlorine and silica, though chlorine is largely supplied in the ammonium-salts.

12. Upon the whole, the comparison of the yield of ash constituents *per acre* over the first and second eight years shows, without manure a small relative exhaustion of both potash and phosphoric acid, and with ammonium-salts a greater relative exhaustion of both.

13. *Per* 1,000 *dry substance of grain* there were taken the average of the sixteen years, almost identical amounts of each of the ash-constituents without manure, and with farm-yard manure; but with ammonium-salts alone there was marked deficiency, especially of phosphoric acid, and in a less degree of potash. *Per* 1,000 *dry substances of straw*, there was, without manure considerably less potash than with farm-yard manure, but otherwise not much difference. With ammonium-salts alone there was still greater deficiency of potash, but more lime, less phosphoric acid, but more sulphuric acid, and considerably less silica, than either without manure or with farm-yard manure.

14. Comparing the amounts of ash constituents per 1,000 *dry substance of the grain, over the first* and *second eight years*, with farm-yard manure they are almost identical over the two periods, and without manure very nearly so, but there is slightly less potash, and more magnesia and phosphoric acid, over the second period—conditions indicating less perfect maturation, that is, less flour in proportion to bran. With ammonium-salts alone the dry substance of the grain shows a marked deficiency of potash and magnesia, and especially of phosphoric acid compared with that of the other plots; it nevertheless shows very little difference comparing the second eight years with the first, though there is a slight decrease of phosphoric acid and increase of sulphuric acid and silica over the second period.

15. *Per* 1,000 *dry substance* of the straw, the amount of the various ash-constituents varies more over the two periods than in the case of the grain, but still comparatively little. Without manure there is over the second period a deficiency of potash and magnesia, partially compensated by lime, also a deficiency of phosphoric acid. With ammonium-salts, the most marked deficiency over the second period is of potash; there is also less chlorine, but more sulphuric acid.

16. In conclusion in regard to this first series of ash analyses, although the results show a much wider range of variation in the mineral composition of the grain due to season than to manuring, there are still distinct differences due to the very different conditions as to manuring; but with each of the three conditions there is comparatively little difference over the first and the second eight years. With ammonium-salts

alone, where there is very abnormal mineral exhaustion, the dry substance of the grain shows relative deficiency of both potash and phosphoric acid, but especially the latter. Upon the whole the results point to great uniformity in the mineral composition of the grain under the different conditions of manuring, provided only that it is perfectly and normally ripened. High or low percentage of nitrogen is also more dependent on the conditions of maturation than on full or limited supply of it by the soil.

SECOND SERIES OF ANALYSES.

1. This series relates to the produce obtained under nine different conditions as to manuring, each in two unfavorable, and in two favorable seasons for the crop. They thus illustrate the influence of characteristic seasons under a great variety of manuring conditions.

2. The manuring conditions were: Farm-yard manure; without manure; superphosphate, and sodium, potassium, and magnesium sulphates; ammonium-salts alone; ammonium-salts and superphosphate; ammonium-salts, superphosphate, and sodium sulphate; ammonium-salts, superphosphate, and potassium sulphate; ammonium-salts, superphosphate, and magnesium sulphate; ammonium-salts, superphosphate, and sodium, potassium, and magnesium sulphates.

3. The four seasons were: 1852 and 1856, which were unfavorable, and 1858 and 1863, which were favorable for the crop; 1852 (the ninth from the commencement of the experiments) was bad both as to quantity and quality of produce; 1856 gave fairly average quantity both of grain and straw, but the crop was unevenly ripened, and the quality of the grain was low; 1858 yielded only a moderate amount of total produce, but more than average proportion and amount of grain, which was of over average quality; 1863 (the twentieth year of the experiments) was the best both as to quantity and quality of produce throughout the forty years, 1844–1883, inclusive.

4. Taking the mean results of the nine plots in each of the four seasons, there was from the first to the fourth season an increase in the weight per bushel of the grain, and in the proportion of grain to straw, and a decrease in the percentages of nitrogen and total mineral matter in the dry substance of the grain. Coincidently with these characters, there was, from the first to the fourth season, great increase in the percentage of potash, and considerable decrease in that of magnesia, and there was great decrease in the percentage of phosphoric acid, and an increase in that of sulphuric acid, *in the grain-ash.*

5. *Calculated per* 1,000 *dry substance of the grain,* there was more potash and less magnesia, and especially much less phosphoric acid, and some more sulphuric acid in the produce of the two later and better seasons. These are indications of higher proportion of flour to bran, that is, of more starch. The variation in the mineral composition is thus associated with variation in the organic composition of the grain.

Per 1,000 *dry substance of the straw*, there was also more potash, less phosphoric acid, and more sulphuric acid in the better seasons.

6. *Calculated per acre*, there was about twice as much grain, nearly one and a half times as much straw, and more than one and a half times as much total produce in the best as in the worst of the four seasons. Of total nitrogen *in the crop per acre*, there was an average of only 38 pounds in 1852, and of 50.1 pounds in 1863; while of the less total quantity in 1852 a considerably larger actual amount remained in the straw. In 1852, 61.6 per cent.; in 1856, 72.9 per cent.; in 1858, 73.8 per cent., and in 1863, 77.4 per cent. of the total nitrogen of the crops was stored up in the grain. In 1863, with the largest actual amount of nitrogen in the grain *per acre*, there was the lowest *percentage of it in the grain;* that is, under the influence of the very favorable growing and maturing conditions, there was a greater accumulation of non-nitrogenous constituents in proportion to the amount of nitrogen stored up.

7. *Calculated per acre*, there was in 1863 one and a third times as much total mineral matter in the crop as in either of the other years. Comparing the best and the worst seasons (1863 and 1852), there was one and a half times as much lime, magnesia, and phosphoric acid, and about twice as much potash and sulphuric acid in the total produce *per acre* in the season of most favorable growth and maturation. Yet, *per* 1,000 *dry substance of the grain*, the amounts of lime, magnesia, and phosphoric acid were lower, and the amount of potash was not much higher in the better seasons.

8. Taking the average results over the four years, for each of the nine different conditions as to manuring separately, there is, with one or two exceptions, comparatively little variation in weight per bushel with the equal season, but very varying manuring conditions; and the differences, such as they are, are consistent. The percentage of nitrogen is also in the main fairly uniform with the different manures; but it is low with mineral manure alone and great nitrogen exhaustion, and high with ammonium-salts alone and relatively excessive nitrogen supply. The percentages of total mineral matter are also fairly uniform, but somewhat higher with farm-yard manure, without manure, and with mineral manure alone, and low with ammonium-salts alone.

9. *Per* 1,000 *dry substance of the grain* there is also general uniformity in the amount of the chief individual ash constituents under the very different manuring conditions. The exceptions to uniformity in the amounts of potash are, that it is somewhat high without manure and with purely mineral manure, and somewhat low with ammonium-salts alone, and with ammonium-salts and superphosphate, but without potash. The exceptions to general uniformity in the amounts of phosphoric acid are, that it is high with farm-yard manure, without manure, and with purely mineral manure, and low with ammonium-salts alone.

10. *Per* 1,000 *dry substance of the straw* the amounts of the individual ash constituents are much more variable on the different plots. The

variation is especially marked in the case of the potash and phosphoric acid, and it is obviously much dependent on their supply. It is also very marked in the case of the silica.

11. *Calculated per acre*, there is very great variation in the amounts of produce, and of its various constituents, according to manure. Without manure and with purely mineral manure, the produce was very small; it was much more with ammonium-salts alone, and much more still with ammonium-salts and mineral manure together. With ammonium-salts and the most complete mineral manure, there was more than one and a half times as much produce as with ammoninm-salts alone, and nearly two and and a half times as much as with mineral manure alone. There were in the main corresponding differences in the amounts of nitrogen, total mineral matter, and the chief individual ash constituent, stored up in the crops.

12. Of potash, the ashes show three times as much in the total produce *per acre* with farm-yard manure and more than three times as much in that with ammonium-salts and mineral manure containing potash, as without manure. On the other plots (excepting with mineral manure alone), the quantities of potash in the crops are obviously dependent on the supply. Of the total potash of the crops, there is generally only from one-fourth to one-third accumulated in the grain.

13. Of phosphoric acid there was little more than twice as much *per acre* in the highly manured as in the unmanured produce; but three-fourths or more of the total phosphoric acid of the crops may be accumulated in the grain.

14. Of the total lime and sulphuric acid of the crop a very small proportion; of the magnesia, generally more than half; of the chlorine, scarcely a trace, and of the silica, the smallest proportion of all, is found in the grain-ashes.

15. With very great variation in the amounts of nitrogen and ash constituents *in the total crop per acre* on the different plots, there is remarkable uniformity in the amounts of each *per* 1,000 *dry substance* of *grain*; but wide variation in the amounts *per* 1,000 *dry substance* of *straw*. The greatest exceptions to uniformity in the amount of potash per 1,000 dry substance of the grain are that it is low with ammonium-salts alone, or with superphosphate only in addition (10*a* and 11*a*), and high without manure, and with purely mineral manure, (3 and 5*a*). The most marked deviations from general uniformity in the amount of phosphoric acid in the dry substance of the grain are, that it is low with ammonium-salts alone (10*a*), and high with farm-yard manure, without manure, and with purely mineral manure (2, 3, and 5*a*).

16. With every condition of manuring there is, *in the grain ashes*, a higher percentage of potash, and a lower of phosphoric acid, and somewhat lower of magnesia also, in the two favorable seasons, indicating higher proportion of flour to bran. There is lower percentage of phosphoric acid in the better seasons, even where there is liberal supply of

it, but the lowest is on plot 10*a*, where it is the most exhausted. The *straw ashes* also show a higher percentage of potash in the two better seasons.

17. With decline in the percentage of phosphoric acid in the ashes there is increase in sulphuric acid, and in the straw ashes increase of chlorine in a greater degree. It is a question how far the small amounts of sulphuric acid and chlorine in the grain ashes are due to the presence of so much acid phosphate, and how far the much larger amounts in the straw ashes are due to their excess of base to acid other than silica, although of this there is so much.

18. *Calculated per* 1,000 *dry substance of the grain*, there is, with every condition as to manuring, a higher amount of potash in 1858, and almost without exception in 1863, than in the two unfavorable seasons. On the other hand, the proportion of phosphoric acid is in 1858 almost without exception, and in 1863 without exception, lower than in the unfavorable seasons.

19. The second series of analyses, as did the first, consistently show considerable variation in the mineral composition of wheat grain, according to season, but little according to manuring (excepting in cases of abnormal exhaustion), provided the seed be properly matured. In fact, variations in the mineral composition are associated with differences in the organic composition.

THIRD SERIES OF ANALYSES.

1. This series was more especially arranged to trace the influence of supply or exhaustion. The ashes represent the produce obtained under ten different conditions as to manuring, each over ten years, 1852–1861, and ten years, 1862–1871. Nine of the plots are substantially duplicates of those to which series two relates; and the tenth, 10*b*, is a duplicate of 10*a*, with ammonium-salts alone, excepting that twice prior to the period now under consideration it received mineral manure, including potash and phosphoric acid, when 10*a* did not.

2. The average results *per acre*, of the ten plots, for each of the two periods, show that the first ten years were on the average the more favorable for luxuriance, that is, for total accumulation by the plant, and the second ten the more favorable for seed formation and maturation. Accordingly, with less mineral matter in the total produce per acre over the second ten years, there was as much or more of almost every individual ash constituent accumulated in the grain.

3. With each condition of manuring where the nitrogen supply was not deficient, there was more grain, and of better quality, over the second ten years. Comparing plot with plot, there was over both periods, with equal nitrogen supply, considerable increase by the addition of superphosphate and potash. Comparing the second period with the first, the influence of supply or exhaustion, especially of potash, is very marked (10*a*, 10*b*, 11*b*, 12*b*, 14*b*, 13*b*, and 7*b*).

4. With equal supply of nitrogen very variable amounts of it are found in the total produce per acre of the different plots according to the associated mineral supply.

5. Of individual ash constituents there was more in the *total produce per acre* with some of the artificial manures than with farm-yard manure. Comparing the plots with equal ammonium-salts, but different potash supply, the amounts of potash in the total produce are in the order of the supply.

6. Comparing plots 12*b*, 13*b*, 14*b*, and 7*b*, all with the same nitrogen supply, but the first and third with a decreasing residue of potash from previous applications, and the second and fourth with an annual supply of it, the amounts of potash in the *total produce per acre per annum* over the first ten years are, 45.4, 53.2, 49.8, and 56.0, but the amounts in the grain are 11.4, 11.3, 11.3, and 11.9; over the second period, with the further exhaustion on the first and third plots (12*b* and 14*b*), the amounts of potash in the total produce are 37.8, 55.2, 39.1, and 53.0, but the amounts accumulated in the grain are 11.4, 12.2, 11.6, and 12.3. Thus the amounts in the total produce are directly influenced by the supply or exhaustion, especially over the second period; but over each period the amounts in the grain are neary identical on the four plots, showing only slight relative deficiency over the second period on plots 12*b* and 14*b*, with their reducing residue of potash supply.

7. The amount of phosphoric acid in the *total produce per acre* varies much with equal supply of it and of nitrogen, and is obviously much dependent on the available supply of potash. The amounts of mineral constituents accumulated in the total plant (as indicated by the amounts in the total crop) are very directly influenced by the supply or exhaustion; but, other things being equal, the final distribution in the grain is influenced much more by the seed-forming characters of the season than by the amounts of the constituents in the total plant, provided there be not a deficiency.

8. *Percentage composition of the ashes.*—As in the case of the mean results from the ten plots, so in that of each plot (excepting plot 3, without manure), there is a higher percentage of potash in the grain ashes of the second period with its better seed-forming and maturing tendencies. The percentage of potash in the grain ashes only varies from 31.7 to 34.0 over the first, and from 32.1 to 34.1 over the second period; but in the straw ashes it varies from 14.8 to 24.1 over the first, and from 14.1 to 25.0 over the second period. The variations in the straw ashes are consistent with the variations in the supply.

9. Comparing plots 12*b*, 13*b*, 14*b*, and 7*b*, the percentages of potash in the grain ashes are over the first period 32.8, 32.9, 32.6, and 32.9, and over the second period 33.3, 33.5, 33.1, and 33.4; but in the straw ashes they are over the first period 20.1, 24.1, 22.0, and 23.7, and over the second period, with the increasing exhaustion on the first and third plots, 12*b* and 14*b*, 17.2, 25.0, 18.5, 24.6.

10. With higher percentages of potash in the grain ashes over the second period, there are also higher percentages of lime, and there is a tendency to higher percentages of magnesia; but there is in every case, excepting without manure, a lower percentage of phosphoric acid, and with this, in every case but one, a higher percentage of sulphuric acid over the second period.

11. *Per* 1,000 *dry substance of the grain* there is generally a lower amount of each ash constituent (excepting lime and sulphuric acid) over the later and better seed-forming and maturing period; there is also a lower amount of nitrogen, and, therefore, a higher proportion of non-nitrogenous constituents. Comparing plot with plot, the amounts of potash *per* 1,000 *dry substance of the grain* are fairly uniform, but even in the grain, and in the straw in a much more marked degree, it is lowest where it is the most exhausted. Comparing plots 12*b*, 13*b*, 14*b*, and 7*b*, the amounts *per* 1,000 *dry* substance of *the grain* are over the first period 6.46, 6.43, 6.41, and 6.53, and over the second period 6.14, 6.22, 6.16, and 6.33; but in the straw they are over the first period 10.54, 12.90, 11.65, and 12.84, and over the second period, with the increasing exhaustion on the first and third plots, 9.14, 13.29, 9.55, and 12.58.

12. The amounts of phosphoric acid *per* 1,000 *dry substance* of *the grain* varied more according to supply than did that of the potash; but it was, with every condition of manuring, lower over the second and more favorable period. Over the first period it ranged from 8.70 to 10.87, and over the second period from 7.89 to 10.35. On Plots 12*b*, 13*b*, 14*b*, and 7*b* it was, over the first period, 10.05, 10.05, 10.15, and 10.12, and over the second period 9.21, 9.31, 9.38, and 9.49, or much lower over the second period, but within each period almost uniform on the four plots. Taking the whole series of plots, it was the lowest on 10*a* and 10*b*, where it was most exhausted; but it was also low on 11*b*, where it was annually supplied, though without potash, and with defective development accordingly.

13. The results of the third series of analyses agree with those of the first and second in showing, upon the whole, marked uniformity in the mineral composition of the ripened grain, even when there is wide variation in that of the straw dependent on supply or exhaustion. They also show distinct influence of season, and that the differences in the mineral composition of the grain due to season are associated with differences in the organic composition. With less variation in the conditions of season, and of influence therefrom, but with a wider range of mineral supply or exhaustion than in the other series, there is a wider range in the mineral composition of the grain, according to supply or exhaustion; it is, however, comparatively little influenced by excess of supply, but more by deficiency. The three series show that, under otherwise comparable conditions, there is, in the better matured grain, that is, in the grain of higher quality, a lower percentage of total mineral matter (ash); *in the ash*, a higher percentage of potash, but lower

of phosphoric acid; but *in the dry substance of the grain* generally a lower percentage of potash, and considerably lower of phosphoric acid, and also a lower percentage of nitrogen

They also add: In conclusion, extensive and comprehensive as has been the inquiry within its own limits, it must be borne in mind that the results relate to the produce obtained on one description of soil, and in one locality only.* Still, the number of very widely different seasons over which the experiments have extended, and the very widely different conditions as to manuring of the different plots, have probably provided a much greater range of conditions of growth than would have been secured had the experiments been made in fewer seasons, on various soils, and in various localities, but with more normal conditions as to manuring. Indeed, the conditions of relative excess, or exhaustion, of the available supply of individual constituents represented in the experiments, the results of which have been recorded, are probably much more distinctive and characteristic than could be obtained under more normal conditions. On this view it is obvious that, while the results are of a very marked character, and are therefore very instructive if properly interpreted, it must not be without careful reservation that their application to the circumstances of actual agricultural practice should be inferred.

THE CONCLUSION OF LAWES AND GILBERT AS VIEWED IN CONNECTION WITH THE RESULTS OF AMERICAN WORK.

Considering the conclusions of these authors by paragraphs as they are numbered, it is found in the first series of analyses and third paragraph that, " taking high weight per bushel of grain as a fairly good indication of high quality, and *vica versa*, there was, with each condition of manuring a general and marked but not uniform tendency to lower proportions of nitrogen, of total mineral constituents (ash), and of individual ash constituents, in the dry substance of the grain of the seasons of higher quality. That is, the higher quality of the grain is associated with the greater accumulation of the non-nitrogenous matters (carbohydrates) in proportion to the nitrogen, and to the mineral constituents which have been stored up." And again, in the body of the report the authors remark: " In a very comprehensive investigation of the composition of American wheats, conducted by Mr. Clifford Richardson under the auspices of the Department of Agriculture, at Washington, he finds a generally low average percentage of albuminoids in American as compared with European wheats; and he concludes that this is an indication of inferiority of quality in many cases due to deficient

* It is true that once within the period to which the results relate there was a change of seed from one description to another not very widely different; but there is no evidence leading to the conclusion that this irregularity has at all vitiated the comparative character of the results, or the legitimacy of the conclusions that have been drawn from them.

supply of nitrogen by the soil. It is more probably due to enhanced formation of starch under the influence of high ripening temperature."

Allowing the correctness of their conclusions in their application to the cases which they have had under consideration and to many local instances in the United States where to similar causes have been very evidently due high or low percentages of nitrogen, they are not, however, justified in attributing the poverty of American wheat in nitrogen as a whole to an enhanced starch formation, and for the following reasons:

An enhanced formation of starch, there being no poverty of nitrogen in the soil, increases the weight of the grain and diminishes the relative percentage of nitrogen. Were this the cause of the relatively low percentage of nitrogen in our American wheats, the grain from the Eastern States, which are poorest in this respect, would be heavier than those from the Middle West, which are richer in albuminoids; but this is not the case. Again, formation of starch is attributed by Messrs. Lawes and Gilbert to the higher ripening temperature in America, but we have found that there is scarcely any difference in composition or weight between wheats from Canada and Alabama and if anything those from Canada contain more starch than those from the South, and the spring wheats from Manitoba with its colder climate more than those from Dakota and Minnesota with its milder temperature. In Oregon there is a striking example of the formation of starch and increase in the size of the grain at the relative expense of the nitrogen due to climate but not to high ripening temperature. The average weight per hundred grains of wheat from this State has been found to be 5.044 grams and the relative percentage of nitrogen 1.37, equivalent to 8.60 of albuminoids. These are the extremes for America and are due, as has been said, to the enhanced formation of starch. This, however, is not owing to high ripening temperature, because most of the specimens were grown west of the Cascade Range, which has an extremely moist climate and a summer temperature not exceeding 82° F. for any daily mean. The climate in another way, however, is of course the cause, by producing luxuriant growth, as illustrated by all the vegetation of the country. Numerous other analyses are illustrations of the important effect of surroundings and season upon the storing of starch and consequent relative changes in the composition of the grain. The crop of Ohio for 1883, for instance, as has been remarked in the previous pages of this report, was shriveled in appearance, owing to wet weather about the time of ripening. The result was that the grain was small in size and of light weight, as it could not store up its usual quantity of starch, and the relative percentage of nitrogen was therefore increased. In Dakota the contrast between a winter and a spring wheat has been shown and the cause determined as lack of starch, and consequently size, in the latter variety, and this holds true as a characteristic of all the spring wheats of the Northwest. They are high in nitrogen, small

in size, and contain a greater proportion of bran to flour than winter wheats.

Another peculiarity, dependent in a like manner on climate or season, appeared last year in Colorado, where storms at the time when the grain is usually collecting its nitrogen interfered with the storage of that element, while a revival of vitality later permitted the usual amount of starch to be elaborated, thus decreasing the relative proportion of albuminoids. As a whole, however, the poverty of American wheat in nitrogen, decreasing toward the less exhausted lands of the West, seem to be due more to influences of soil than of climate, while locally the conclusions in paragraph six of the first series of experiments, that the influence of season is greater than that of manure, are confirmed by the crops of 1883 in Ohio and Colorado.

As far as our experiments have gone in the direction of milling the conclusions of paragraph nine are confirmed in every respect, especially as to the greatest concentration of nitrogen being immediately below the pericarp (epicarp of our description). From the analyses of the ash of different parts of the grain they learn, as can be seen in our analyses of roller-milling products, that a large percentage of ash constituents, other things being equal, is indicative of large proportion of bran.

Comparing the crops on an unmanured plot for sixteen years their results seem to show that while the proportion of grain to straw gained during the second half of the period and the weight per bushel changed but little, the relative percentages of nitrogen in the dry matter of the grain and straw decreased noticeably, and this was the case, too, upon the plot manured with ammonium salts alone, showing an intimate connection between the mineral constituents of the grain and the nitrogen. If we may be allowed to consider the grain which has been analyzed from the Western States as corresponding to the first period of eight years of Messrs. Lawes and Gilbert's experiments, and that from the Eastern States as corresponding to the second, then there is a thorough agreement between the two series, the Eastern representing the more worn out and the Western the less exhausted soil, and the conclusions for the English experiments hold good for our wheats. That is to say, the soils of the Eastern States, upon which wheat (or other crops) have been grown for many years without sufficient manure, do not produce for that reason a grain as rich in ash and nitrogen as the fresher soils of the West. When it is possible to carry out extensive experiments in this country under as complete control as those at Rothamsted it will be possible to show this fact in a more particular way.

The second series of experiments brings out the effect of season more strongly than the first but with the same result as has been already discussed. It shows, too, a fact that we have no data for, namely, that

in bad seasons with poor or scanty nourishment the straw suffers more in relative composition than the grain.

From the third series we learn that with numerous conditions of manuring there was more grain and of better quality over the second ten years, and that the amount of nitrogen found in the produce with equal supply was dependent on the associated mineral supply. This seems to show that the application of mineral manures to our Eastern lands should bring up the yield of grain and the quality, as far as we are able to judge and profit by these experiments abroad. Work of a similar character at home would certainly open a vast field of information and be of great benefit to the American farmer who is desirous of cultivating his ground on rational principles, but he will be able to gather from these English experiments much which will be to his advantage if they only serve to show the great susceptibility of wheat to its surroundings.

In another place it is intended to take up the relations of corn (maize) to climate, soil, and season in the same manure as has been done with wheat. It can only be said here that our results have shown that it is the quantity per acre and not the quality of corn which is affected most by conditions of environment.

ERRATA TO BULLETIN NO. 1.

Page 4. No. 722, Blount's Hybrid "No. 16," read "No. 17."
No. 723, Blount's Hybrid "No. 17." read "No. 18."
No. 725, Blount's Hybrid "No. 20," read "No. 21."

Page 5. No. 725, Hybrid "No. 20," read "No. 21."

Page 31. For nitrogen in Alabama wheat read "1.82" instead of "1.79."

Page 37. No. 725, in table, Blount's Hybrid "No. 20," read "No. 21."

Page 41. In last table on the page read for weight of 100 grains in 1882 "4.233" instead of "4.682."

Page 43. "In Virginia a stinted wheat," read "a stunted wheat."

Page 63. Under Colorado for "Blount's Prolific, Flint," read "White Dent."

Page 68. For weight of 100 kernels Field corn, read "36.910" instead of ".910."

Page 69. Twelve lines from foot of page, read "and corn 3.17 per cent." instead of "2.8."